DEPARTMENT OF THE ARMY
Headquarters, US Army Communications-Electronics Command
Research, Development, and Engineering Center
Fort Monmouth, New Jersey 07703

REPLY TO
ATTENTION OF:

AMSEL-RD-C2-SS-T 9 May 2003

FOR Bonnie Mottram, Evidence Based Research, Inc

SUBJECT: Paper for 8th International Command and Control Research and Technology Symposium

1. Attached please find the paper my colleague and I wish to publish and present at the subject Symposium. The paper and presentation describe on-going R&D and would fit best under the C2 Experimentation topic but any one of the following topics will also be appropriate in order of priority:

Coalition Interoperability
Modeling & Simulation
Network-Centric Applications
Information Age Transformation.
C2 Assessment Tools & Metrics

2. The paper is being processed for Public release. We do not see any problem getting it released. But please do not publish it until you hear from me that it was approved for public release..

For coordination with respect to this paper please contact

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3. CECOM Bottom Line: THE WARFIGHTER

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Report Documentation Page

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Multinational C2 Experiments Supported by C2 Systems and Modeling and Simulations Addressing Army Transformation of Collaborative Planning and Interoperable Execution in a Coalition Environment

Submitted to Track 2: Command and Control Experimentation
or
Coalition Interoperability
Modeling & Simulation
Network-Centric Applications
Information Age Transformation.
C2 Assessment Tools & Metrics

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Abstract

Future deployments of Objective Force units are required to be not only network-centric with respect to their own assets but also with respect to other Joint, National and Coalition assets. The main issue for any network-centric architecture is how to establish connectivity, federation, collaboration and interoperability in a self organizing way among all elements of the force to include combat, combat support, combat service support and C2 assets. When a combat force element such as a unit of action (UA) combat team or task force is organized it may include assets and resources that are not organic and include cross-attached coalition elements. Its combat support forces, combat service support as well as its C2 resources will most likely also require subordinated coalition elements. This necessitates a well thought out alignment of the different C2 processes employed by each of the coalition partners to enable and assure unity of command, synchronization of the tasks and critical battle space de-confliction. The recommended technical solutions and possible changes to tactic, techniques and procedures essential to achieve that alignment must be subject to a rigorous experimentation program supported by evolving C2 systems stimulated by combat simulations that would ensure outmost flexibility to support the full spectrum of operational needs. In addition, the capabilities of Joint, National and Coalition assets to partner with us must also be taken into account.

1.0 Introduction

This paper describes the integrated C2 and Modeling and Simulation (M&S) systems environment and approach the US is designing and implementing to support the conduct of such experiments. Progress is being made to represent various Information Exchange Requirements (IERs) including OPORDs and associated messages such as the Position Reports and SPOT Reports using common XML elements and attributes as well as similar XML schemas. Filtering of information that needs to take place to appropriately support effective collaboration and interoperability as well as for stimulating the exchange via combat simulations is highly flexible. It addresses source, content, time and location as basic criteria. Adopting and adapting evolving mechanisms to assure interoperability between C2 systems as a direct result of events generated in real-time by the M&S systems being used in this experimentation environment is key to driving the combat situation that provides context to these experiments. In addition, we will share our results in our efforts to align domain items with the Battle Management Language (BML) [7], the Joint Common Data Base (JCDB)[10], and the Army Tactical C2 Information System (ATCCIS)[11] Land C2 Information Exchange Data Model (LC2IEDM)[11]. To facilitate collaboration between current and future allies with disparate means for collaboration, we've have found it both necessary and convenient to provide Web services that include a Web C2 Browser (WebC2B) which enables the sharing of coalition domain items such as the coalition Common Operational Picture (COP) and the coalition plans and orders. We have also initiated the representation of the architecture of this experimentation environment in UML[9] and identified key use cases and issues for each of the four phases essential for network-centric C2 system of systems (SoS) integration: inter-connection, inter-federation, inter-collaboration and inter-operation.

2.0 Background

Since the end of the cold war, the US military has found itself challenged to support full spectrum of operations as part of a coalition force. Over the course of CY2003, a concerted and collaborative effort has been initiated and is underway to couple representative US Army and German (GE) Army C2 systems and appropriate M&S systems in a realistic coalition C2 experimentation environment. A Project Agreement has been signed by both the US and GE to pave the way and ensure support from both materiel and user communities standpoints for the execution of the proposed experiments. The intent is to set the stage for subsequent experiments in which other allied nations will be invited to participate. The name of this experimentation program is Simulation and C2 Information System Connectivity Experiment (SINCE)[1]. Over the past year, the SINCE Program has established a Technical Working Group (TWG) and an Operational Working Group (OWG) that design the experiments and are resourced to integrate the selected C2 and M&S systems, instrument the data collection, run the experiment, analyze the data, and develop conclusions and make recommendations. The OWG and TWG report to the Program Management Group (PMG) that maintains oversight to

ensure progress and agreement as to the overall operational, system and technical architectures that will govern the scope of the experimentation.

3.0 Objectives

The goal of the SINCE Program is to support Army transformation into a more collaborative and interoperable component of a Joint, National and Coalition Force. This goal will be realized in part, by a set of objectives to be achieved by performing a series of experiments to define, examine and test various hypotheses that support different conceptual approaches with respect to operational and technical levels of collaboration and interoperability possible in various configurations of implementing C2 in various coalition environments. It is important to be able to explore the limitations, utility, and interaction between interoperability and real-time collaboration capabilities. A fundamental motivating hypothesis is that C2 is facilitated by a high degree of collaboration during military decision-making process (MDMP)[13] that will exploit the highest level of interoperability possible during execution. This requires that the MDMP must be able to run concurrently with battle management, execution monitoring and situation assessment processes stimulated by the external environment. The optimum points for collaboration within the MDMP process and for interoperability within the battle management, execution monitoring and situation assessment processes are also subject to experimentation. In this paper, we introduce the key concepts, architectural considerations and design necessary to support such experiments that are under development. The first experiment is planned to take place in November 2003. We review standard practices in accordance with established doctrine, explore opportunities to investigate more specific hypotheses and describe the operational and technical environment in which we plan to experiment during the course of the program.

4.0 Experimentation

4.1 Experimental Approach

Subject Matter Experts (SMEs) and users from Battle Command Battle Lab (BCBL) and Mounted Maneuver Battle Lab (MMBL) participate in the OWG with their GE counterparts to define the scenario events, vignettes, use cases and actors and the associated Information Exchange Requirements (IER). These IERs are further refined into operational domain products such as operations orders (OPORDs) and various reports and embedded domain objects that must be supported by the C2 System and whose states must be evolved and updated by the federated coalition simulation systems. Therein lies the essence of the SINCE Program, i.e., C2 systems are coupled to simulation systems which maintain ground truth and stimulate the C2 systems to maintain situation awareness. The C2 systems in turn, create and modify the plans of the simulated subordinate units. Engineers and scientists from Army Labs participate in the TWG with their GE counterparts to develop and /or adapt the XML representations of the IERs and align, map and filter the domain items that must flow between and among interconnected systems, subsystems and components. The OWG and TWG develop their own implementation plans that identify affordable resources and configurations of

personnel, hardware, software and communications. The technical implementation plan must support the operational implementation plan. These implementation plans are flexible enough to support multiple experiments governed by an operational and technical experimentation plan. The experimentation plans address a number of hypotheses for testing and evaluating of the technical and operational concepts implemented for the conduct of the experiments. These plans establish the basis for experimentation collection for data verification and measures of performance analyses.

4.2 Experimenting with Coalition Liaison

A key operational hypothesis that will be evaluated during the conduct of SINCE is the need, time and place for conducting face-to-face liaison during the execution of coalition planning and operations. During the conduct of these experiments, while stimulated by interoperability and M&S technologies, the use of appropriate, network-centric, electronic collaboration technology will be substituted for face-to-face liaison in support of planning and situation assessments. The baseline need for Coalition Liaison is established in accordance with STANAG 2101 [2]. That standard agreement dates back to the cold war era and assumes that there is room to accommodate one ore more liaison officers, and their own equipments. This assumption may no longer be valid or even possible to implement given the highly mobile forces of today such as the Stryker Brigade and the Future Combat System of tomorrow. The term "liaison" refers to the "contact or intercommunication maintained between elements of military forces to ensure mutual understanding and unity of purpose and action."[3]

Typically liaison functionality that is accomplished via face-to-face contact attempts to ensure "cooperation and understanding between commanders and staffs of headquarters or units that are working together, and to establish tactical unity and mutual support of adjacent front-line units." With the advent of decision support, collaborative planning, and situation awareness technologies, the need for face-to-face discussions may become unnecessary and even obsolete. But no one has ever conducted an experiment to investigate or demonstrate this. Upon reviewing the documents that describe liaison functionality, it becomes apparent that the liaison role must be more than a mere formality. It may even hold the key to a successful operation. The primary concern of liaison is to coordinate the coalition combat and operational battle space and to track and provide early warning on significant/critical events and pending mission assignments. Liaison personnel must be familiar with the staff and operational organizations, doctrine and procedures of the force with which they will work as well as being subject matter experts on particular combat, combat support, and combat service support functions of the units which they represent. Liaison officers must be able to perform duties that are typically carried out by any commander's staff. These include but are not limited to the following:

a. track the battle,
b. coordinate combat information,
c. advise on the use of coalition units capabilities to conduct combat, combat support, and combat service support.

d. integrate into the supported unit's operations by understanding the higher echelon OPORD, commander's intent, and understanding the supported unit's scheme of combat.
e. Prepare the assigned portion of plans and orders.
f. Establish and maintain communications between the combat support units and the supported unit.
g. Coordinate combat operations:
   (1). Within the combat force.
   (2). With area and regional commands.
   (3). With elements of other services.
   (4). With other allies in the area of operations.
h. Plan and co-ordinate the battle space use with coalition units.
i. Assist staff in analyzing enemy capabilities and determining measures to counter enemy courses of action (CoAs).
j. Monitor readiness status of coalition units.
k. Advise on impact of coalition support upon combat operations.
l. Plan and supervise assigned missions and tasks within area of operation.
m. Develop or review coalition and joint rules and procedures.

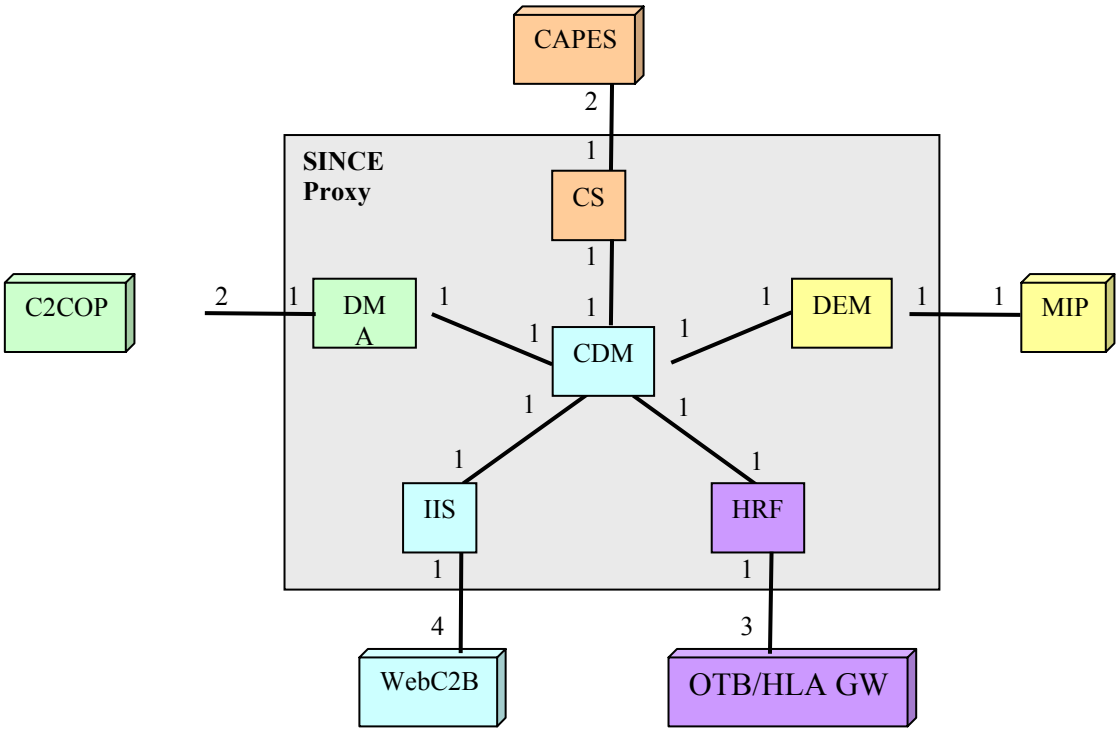

Figure 1: SINCE Overall Architecture for Experiment 1 (US Side only)

4.3 Overall Architecture

For the first in a series of at least three experiments, the overall architecture for the US side is shown in the Figure 1 below. Implementation of this architecture involves synchronization of five concurrent development and integration efforts, that will enable the user experimentation within 10 months of their initiation by both the US and Germany. The US experimental set up includes two complementary C2 systems, a web system, a Multilateral Interoperability Programme (MIP)[4] interface and a combat simulation system. The two US Army C2 systems shown are the Combined Arms Planning and Execution System (CAPES) that evolved out the Agile Commander ATD and the C2 Common Operational Picture (C2COP) system that reuses Army Battlefield C2 System (ABCS) software. For the US combat simulator we are using the OneSAF Test Bed (OTB)[6] system. For interoperability we are collaborating with MIP to integrate their Data Exchange Mechanism (DEM) component into the SINCE Proxy Server. The Web services are also being integrated within the SINCE Proxy Server using Microsoft Internet Information Server (IIS) and the Internet Explorer as the framework for the WebC2B.

A key aspect of our architecture in the SINCE Program is the isolation of the coalition interfaces and web services, and the coupling of the modeling and simulation through a proxy server. This allows the national C2 systems to evolve independently of the coalition collaboration and interoperability solutions, as well as independently of the Joint interfaces and the simulation based stimulation environment for mission rehearsal, and training systems. Coalition simulators are federated using the IEEE Standard for the High Level Architecture (HLA)[5] that includes federation rules, Real-time Infrastructure (RTI), and an agreed upon Federation Object Model (FOM). For Experiment 1, we agreed to use a subset of the Real-time Platform Report (RPR FOM 2.0) and the DMSO RTI, Version 4.0.

Another key aspect of our architecture is the use of web services via a web browser to insulate the national planning systems and situation awareness systems from the ally planning and situation awareness systems. This allows national security considerations to be preserved and impose a low cost fielding solution with minimal training requirements for the liaison officers.

4.3.1 The Proxy Server (PS) and the PS_CDM

The SINCE Proxy Server serves as a bridge, a filter, an adapter and a repository for all IERs and associated data collection. It bridges and filters collaboration between the CAPES Collaboration Server (CS) subsystem which supports a strictly US collaborative environment and the WebC2B which supports a strictly coalition collaborative environment to be integrated with the SINCE Proxy Coalition Domain Manager (CDM) subsystem. Our approach to conduct a US-only dry runs prior to any international experiment require that we provide additional PSs as surrogates for any ally PS system.

4.3.2 The CAPES and the PS_CS

The CAPES is an operational prototype based upon the Agile Commander Toolkit software being transitioned to ABCS. It is also anticipated that CAPES will be integrated into Transformation Force C2 Systems such as FCS. The CAPES will be responsible for displaying, updating, maintaining and providing access to the US COP/Plans and the Coalition COP/Plans IAW with the JCDB Data Model (JDM)/Agile Commander Data Model (ACDM). The SINCE PS CS (Collaboration Server) subsystem is a component of the SINCE PS that serves as a bridge for collaborative coalition planning (at Brigade and Battalion levels) that must be mapped between the US collaborative planning tools and the ally collaborative planning tools.

4.3.3 The C2COP SYSTEM and the PS_DMA

The C2COP system is an operational prototype based upon ABCS COP software typically found in MCS TOC Server, ASAS-Light, and FBCB2. The C2COP will be responsible for displaying, updating, maintaining and providing access to the US COP and Plans and the Coalition COP and Plans in accordance with the JCDB Data Model (JDM). We expect that this C2COP functionality will also be integrated into Transformation Force C2 Systems such as FCS. The SINCE PS DMA (Data Model Adapter) subsystem is a component of the SINCE PS that serves as a bridge for ally reports/updates (Friendly Status and Observations) that must be mapped between the LC2IEDM and the Joint Data Model (JDM) of the JCDB.

4.3.4 The WEBC2B SYSTEM and the PS_IIS

The WebC2B plays multiple roles. It plays an operational role by supporting a) our ally when its liaison officer is located in a US unit or b) our own liaison element when located at an allied unit. It provides the means to participate in the conduct of collaborative planning and in providing access to the coalition COP. It also provides the Blue M&S controllers with access to the OPORD that contains the tasks to the units being simulated. Using the BML language automated means is being developed to control simulated units directly from the WebC2B. Another role for the WebC2B is to provide navigational tools to browse the OPORD both textually and graphically. In additions the WebC2 Browser is made available to an ally, joint or even civilian users to enable them to collaborate even in the absence of their own planning systems. The IIS includes a database capability for coalition access through the WebC2B.

4.3.5 The Ally MIP SYSTEM and the PS_DEM

The SINCE PS MIP DEM subsystem is a component of the SINCE PS that serves as a bridge for ally reports/updates (Friendly Status and Enemy Observations) that must be mapped between the LC2IEDM and the Joint Data Model (JDM) of the JCDB. As part of the national testbed program, we are developing an external MIP System Driver as a surrogate to represent a MIP-DEM-compliant ally system that will be used for testing and experimentation in national-only configurations. The MIP DEM is stimulated directly by the national simulation systems to induce situation awareness at the coalition level.

4.3.6 The OneSAF Testbed (OTB) SYSTEM and the PS_HRF

The OTB system includes three workstations that are necessary to maintain a realistic stimulus to the coalition force: One OTB is needed to control the US Blue subordinates.

Another OTB is needed to control the enemy entities. A third OTB is needed to provide situation awareness, data fusion and information distribution to the federation. In the SINCE experiments only the national C2 systems subscribe to the OTB SA. For the US C2 systems this occurs through the PS_HRF subsystem. Since OTB is presently only DIS compliant, we use an available HLA gateway to federate OTB with external systems. We use BC 2010, an HLA-compliant simulator to represent an ally simulator to test the HLA federation during dry runs or limited US experimentation. One set of hypotheses to be tested with respect to the MS systems is with respect to terrain data. How will the COP change and what operationally significant discrepancies will be introduced if

a) terrain data of different terrain elevation resolution is used?
b) each simulator uses different terrain features?
c) we exchange terrain data between allies?

If these hypotheses prove true, can preprocessing the raw data mitigate discrepancies? Other potential discrepancies exist in the repertoire of commands that each simulation is able to support and in differing implementations of identical commands. Also of interest for the case where there is cross attachments, it is important to understand which orders may be used interchangeably with allied subordinates?

5.0 Concept of Experimentation

The SINCE experiments is conducted to address three abstract dimensions in an integrated way: People (Commander and Staff), Technology (C2 systems coupled to modeling and simulation systems) and Operations (Conflicts and Missions). Each of these abstract dimensions consists of a number of sequential yet interruptible and reentrant phases as shown in Figure 2. The red, blue, or lavendar phases corespond to the people, technology, or operations dimension, respectively. Orthogonal to each of these dimensions are three concurrent tracks of activites: a) stimulation, b)planning, and c) execution. These dimensions, phases and tracks will occur in each of the SINCE experiments proceeding from a) simple to more complex scenarios, vingnetes and IERs, b) simple to more complex networking and functionality, and c) small to large number of coalition and Joint partners.

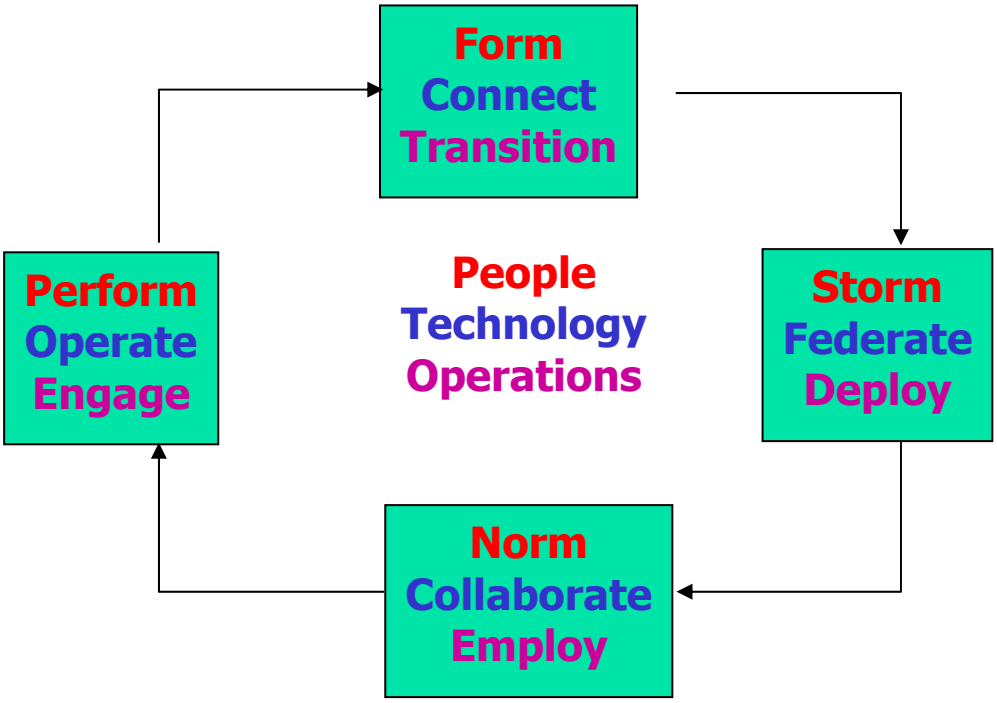

Figure 2: Analog Phases of **Team Building**, **SoS Integration**, and **Mission Execution**

The four sequential phases for each dimension under experimentation were motivated and derived from Druckman's teambuilding paradigm[12] as depicted in Figure 2. In building a team as a coherent organizational unit, whether for sports, a process, a product or combat, it essential for the individual team members to learn how best to perform as a team or as a team of teams (ToT). This learning process typically requires a number of phases or stages. Druckman's paradigm is one of the best known for providing insight into team building. The four distinct phases for teambuilding as shown in red in Figure 2 include: a) the **forming phase** which brings the members together, b) the **storming phase** which allows members to assert their role in the team, c) The **norming phase** which allows members to agree how best to employ their role toward a common goal, and finally d) the **performing phase** which allows members to apply and exercise their skills and execute IAW their agreed upon roles.

Tuckman's Forming-Storming-Norming-Performing theory may be extended and applied to systems technology as well as to operations. Since systems augment individuals or groups of individuals, the system of systems (SoS) augments the team. Therefore, as team members undergo the four phases of team building, individual systems also must undergo analog phases. These phases are shown in blue in Figure 2: a) the **connecting phase** links and networks the systems together to enable them to exchange information with respect to a given syntax/format type, b) the **federating phase** allows systems to assert their functionality and responsibility with respect to a given content type, c) The **collaborating phase** allows systems to support their users in the norming phase to agree how best to employ their assets with respect to a given situation toward a common mission, and finally d) the **operating phase** allows systems to support their users in the

performing phase to interoperate and maintain situation awareness, to exercise battle management and execute IAW their overall intent, concept of operation, and mission.

Along the operational dimension, one may also apply the teambuilding concept to missions. Every mission, starts from a previous mission. The time needed to disengage or unwind from a previous mission and be prepared to understand and handle a new mission is the transition phase. Once the new mission is understood and preparations have been made, the deployment phase of a mission is initiated to dispatch assets to the vicinity of the next engagement area. In the third phase of mission development, assets evolve into the employ phase of the mission, in which planning takes place to determine the right time and place to initiate the engagement part of the mission. In the forth phase of the mission, resources are engaged until the mission succeed or fails.

6.0 Summarizing Conclusion

Experimental results will only be available after we conduct the first experiment in November 2003. Nevertheless, we have developed a comprehensive international program and initiated the development and integration of a long-term testbed with a robust architecture and an experimental framework to address key issues of C2 for the Transformation Force. The use of UML to design the experimental architecture has proven invaluable. The use of XML to provide a common coalition domain model is facilitating integration and bridging between disparate data models. We are leveraging existing C2 prototypes for planning and execution monitoring and coupling them to existing M&S systems to provide a dynamic operational environment. Our first experiment with Germany is under development and is scheduled for implementation in November 2003. Both countries are collaborating on a common scenario, hypotheses, and establishing mechanisms to couple complementary C2 systems to national M&S systems. The M&S systems are also being federated using HLA employing a common RTI and FOM to provide a common ground truth.

7.0 Acknowledgment

The authors would like to acknowledge our sponsors at HQDA and OSD. Our AMC facilitator Stephen Connors whose timely help in getting the agreement approved was invaluable, our systems and subsystem developers and our user representatives. Our own internal staff is acknowledged for establishing the contractual vehicles to develop our architecture and infrastructure. Our SINCE developers are acknowledged for supporting us in development and integration of the experiment HW/SW and Networking environments. In addition we would like to thank our GE Liaison Officer, Maik Kammerman for facilitating the collaboration with our GE counterparts, our Exchange Engineers, MAJ Avi Yariv (IDF) and Alfred Schloesser for valuable UML and XML analysis and design contributions. Our user representatives LTC Peter Itao, BCBL John Langston (Ret.), are acknowledged for developing the operational aspects of the experiment and identifying the IERs and Dave Estes, MMBL, is acknowledged for OTB/M&S Support.

8.0 References

1. SINCE - http://since-program.net
2. STANAG 2101, Edition 9, Establishing Liaison, 25 April 1996.
3. Quadripartite Standardization Agreement (QSTAG) Number 2008 Edition 1, PRINCIPLES AND PROCEDURES FOR ESTABLISHING AIR DEFENSE LIAISON, 6 Sep 2000
4. MIP - http://www.mip-site.org/home.htm
   http://www.mip-site.org/MIP_Baseline_1.htm
5. HLA - https://www.dmso.mil/public/transition/hla/
6. OTB - http://www.onesaf.org/
7. BML - http://www.uxxi.org/docs/c4i-repository/BML.pdf
   http://www.uxxi.org/c4i.html
8. XML - http://www.w3.org/XML/
9. UML - http://www.omg.org/technology/uml/index.htm
10. JCDB - http://diides.ncr.disa.mil/shade/dbsegments/dbseg_list.cfm
11. ATCCIS/LC2IEDM - http://www.mip-site.org/ATCCIS/ATCCIS_Home.htm
12. Teambuilding
    http://www.businessballs.com/tuckmanformingstormingnormingperforming.htm
    http://www.rugbycoach.com/club/teambuild/intro.htm
13. MDMP - FM101-5 Staff Organization and Operations, HQ, Department of the Army, (in PDF format)

US-GE Coalition C2 R&D Technology Program

Simulation & C2 Information Systems Connectivity Experiments (SINCE)

- Presented to 8th International C2 Research and Technology Symposium
- Briefer: Dr. Israel Mayk
- Chair, SINCE TWG(US): US Army CERDEC C2D C2 SoS Division
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Introduction

- This presentation describes the goals and implementation approach of the US national program supporting Transformation efforts for multi-national command and control (via a bilateral approach (US and Germany).
- In the conduct of the SINCE program, both the US and Germany will be tying together appropriate Command and Control Information Systems (C2IS) and Modeling and Simulation (M&S) systems as necessary to support these experimentation activities
- These experiments will focus on the conduct of collaborative Mission Planning and Execution Management activities as needed to support coalition force operations
  - ⇨ Improving information exchange interoperability and situation understanding
  - ⇨ Streamlining/improving decision making process for commanders
  - ⇨ Demonstrating the use of M&S to support the Decision Making Process
  - ⇨ Combined military user and development community participation
- Each nation has and will implement its own unique national approach for supporting and participating in SINCE.
- The US and Germany are jointly working to define and implement common information exchange mechanisms needed to support SINCE

Program Objectives

The goals of the US SINCE program are to:

- Provide US Army Objective Force and Future Combat System (FCS) Commanders operating in coalition operations with improved means for
  - ⇨ visualizing the coalition battlespace
  - ⇨ planning, executing and managing coalition operations,
  - ⇨ performing real-time collaboration and information exchange with coalition partners
- Demonstrate new, affordable, and enhanced means for achieving interoperability between evolving Objective Force/FCS C2IS and those of our coalition partners
- Integrate and use M&S technologies to facilitate/support Combined Operations

SINCE Implementation Concepts

Thrust Areas:

- Brigade and Battalion Level CJTF Operations in an future 2010 Objective Force/Future Combat System (FCS) environment
- Shared Situational Understanding is critical
  - ⇨Understanding via one's own C2 system
- Execution Monitoring using National C2 systems
  - ⇨Supports national, doctrinal approaches to operations
  - ⇨Uses embedded, synthetic environments to drive C2 interoperability
- Evaluation of new C2 System interoperability concepts
  - ⇨Redefine Combined Operations C2 paradigm (e.g. STANAG)
  - ⇨Ultimately drives the technical approach to international C2 systems interoperability.

SINCE Experimentation Program Schedule

1a. Establish technical feasibility and ensure the connectivity and interoperability of all C2/ M&S systems

- Experiment 1a (Technical Connectivity)
- Done at Greding
- Technical in nature/ Operational oversight
- TWG has lead

2. Determine the next level technical feasibility and ensure the updated connectivity and interoperability of all C2/ M&S systems

Nov 03 Apr 04 Jun 05 Mar 06

Quarter	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Experiment 1a														
Experiment 1b														
Experiment 2														
Experiment 3														

- 2nd Experiment
- Done a UAMBL & Greding
- Operational in nature (focus at Bn Level)
- OWG/UAMBL has lead

- 3rd Experiment
- Done a UMAMBL, BCBL and /or JFCOM
- Operational in nature (fucus as CJTF level)
- OWG/UAMBL has lead

1b. Scenario that is constrained by the IER within the C2 systems and by the interoperability constraints of the simulation systems

- Experiment 1b (Operational Checkout)
- Done at Ft. Monmouth and Greding
- Operational nature w/ Technical oversight
- OWG has lead (potential use of CFBL net)

3. Complex military scenario (across the spectrum of war – support ops to mid intensity) unconstrained by earlier limitations of C2 systems and interoperability

SINCE Experiment 1a: Schedule

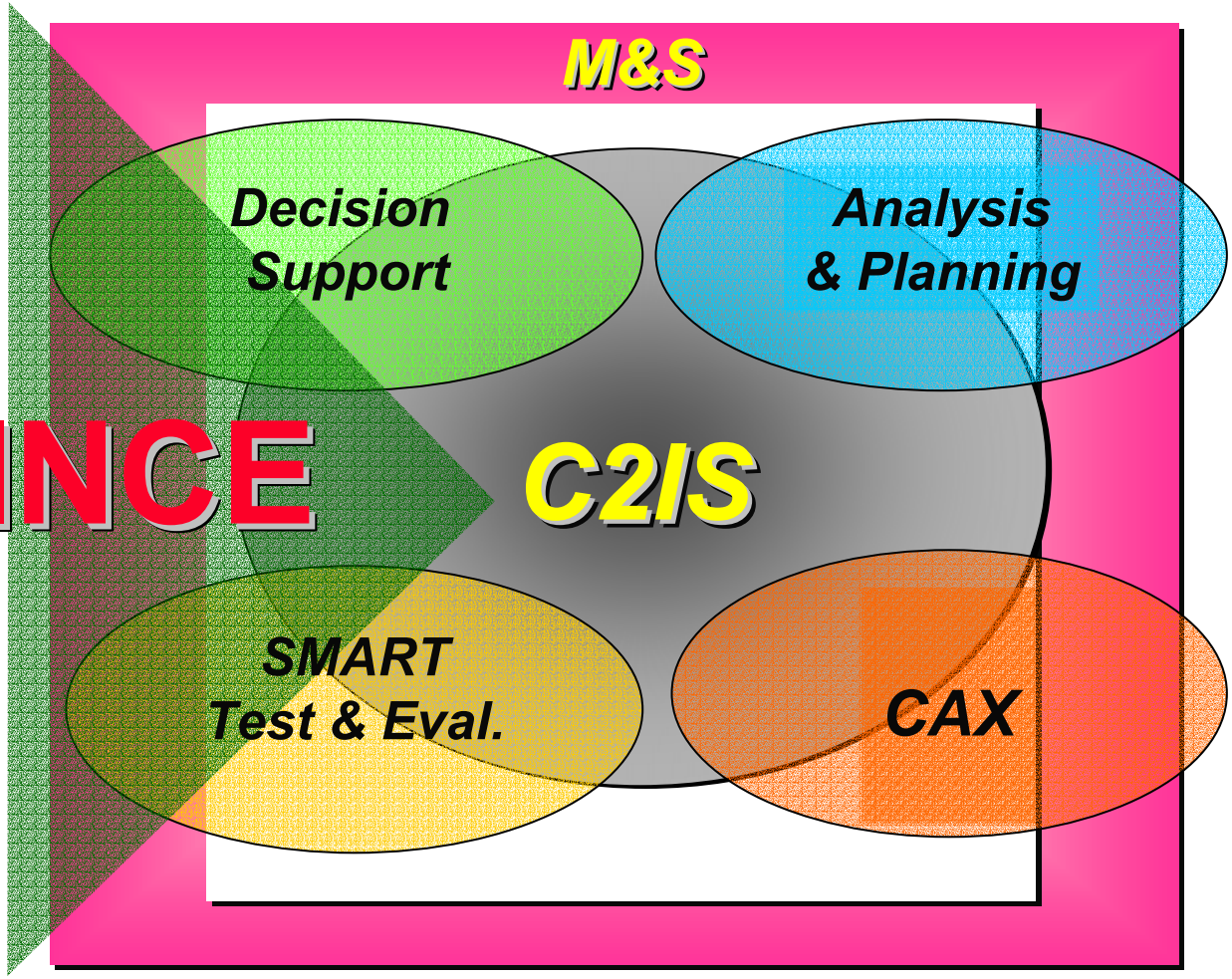
			SINCE Testing						SINCE Experiment				
			Connectivity			Federation			Collaboration			Interoperability.	
			Day 1 Mon.	Day 2 Tue.	Day 3 Wed.	Day 4 Thu.	Day 5 Fri.	Day 6-7 Weekend.	Day 8 Mon.	Day 9 Tue.	Day 10 Wed.	Day 11 Tue.	Day 12 Fri.
Experim't Control (M&S)	SINCE Proxy OTB		Stand Alone Installation And Configuration	Uni-National Systems Network Configuration	Multi-National Systems Network Configuration	Update all data Bases Database tests w/ technicians	Crawl-through Scripted Walk-through Scripted						TWG AAR
						Technician Training	Run-through Script Ad hoc run				Plan for Ad hoc Iteration(s)		OWG AAR Experiment 1b Update
Experiment	Planning	CAPES WebC2B				Update all data bases Database tests w/ technicians	Crawl-through Scripted Walk-through Scripted	OPEN	Scripted Mission Run Iteration 1	Update System Configurations	Scripted Mission Run Iteration 4	Ad hoc Mission Run Iteration 1	TWG AAR
						Operator & technician Training	Run-through Scripted Ad hoc run		Scripted Mission Run Iteration 2	Scripted Mission Run Iteration 3	Plan for Ad hoc Iteration	Ad hoc Mission Run Iteration 2	OWG AAR Experiment 1b Update
	Execution	C2COP WebC2B				Update all data Bases Database tests w/ technicians	Crawl-through Scripted Walk-through Scripted		Scripted Mission Run Iteration 1	Internal AAR With BN level Operators	Scripted Mission Run Iteration 4	Ad hoc Mission Run Iteration 1	TWG AAR
						Operator & technician Training	Run-through Scripted Ad hoc run		Scripted Mission Run Iteration 2	Scripted Mission Run Iteration 3	Internal AAR With BN level Operators	Ad hoc Mission Run Iteration 2	OWG AAR Experiment 1b Update
						TRAINING			Execute scripted Missions/Tasks			Execute Ad hoc Tasks	

Battalion | Company

CECOM Bottom Line: THE WARFIGHTER

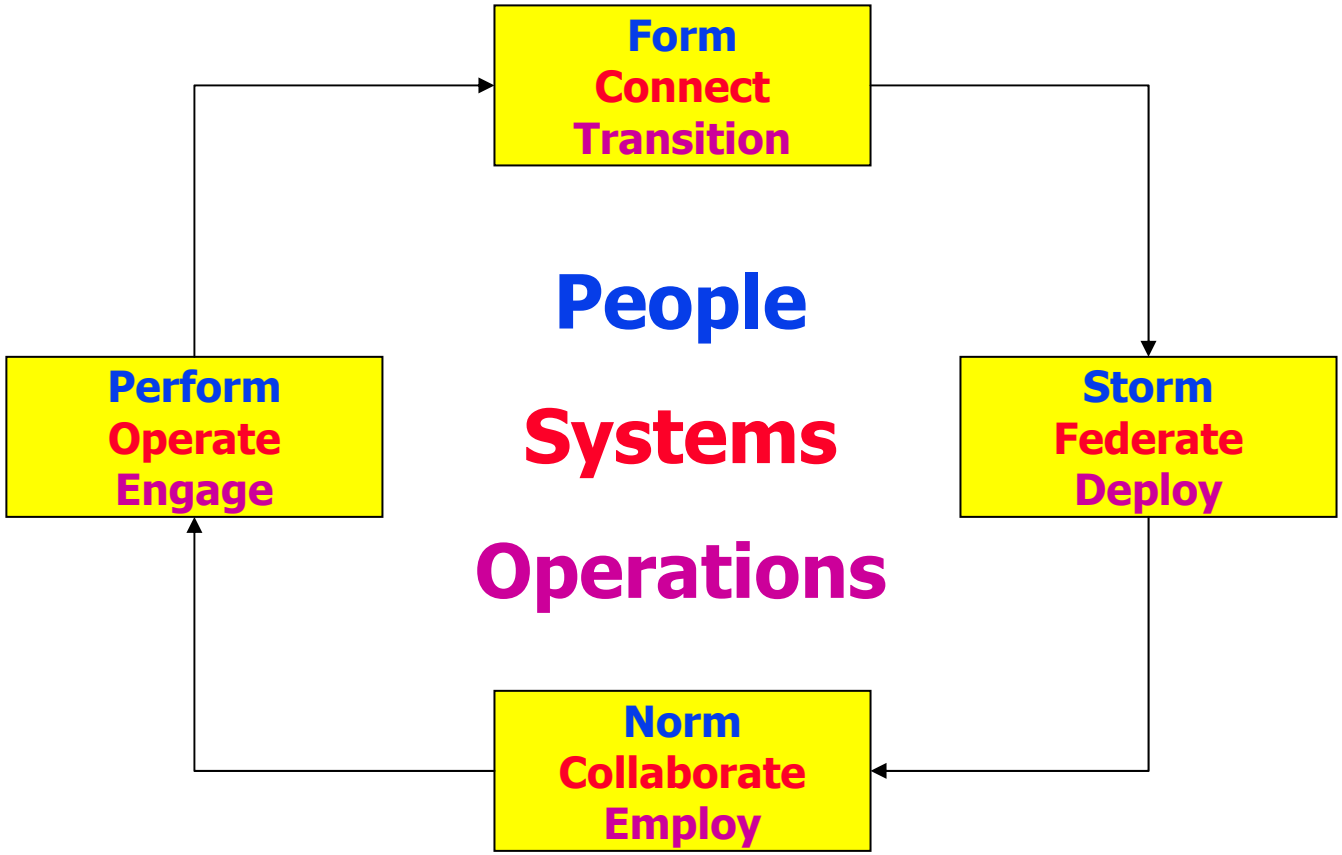
Bridging the Technical & Operational Problems

Simulation Systems Meet C2IS



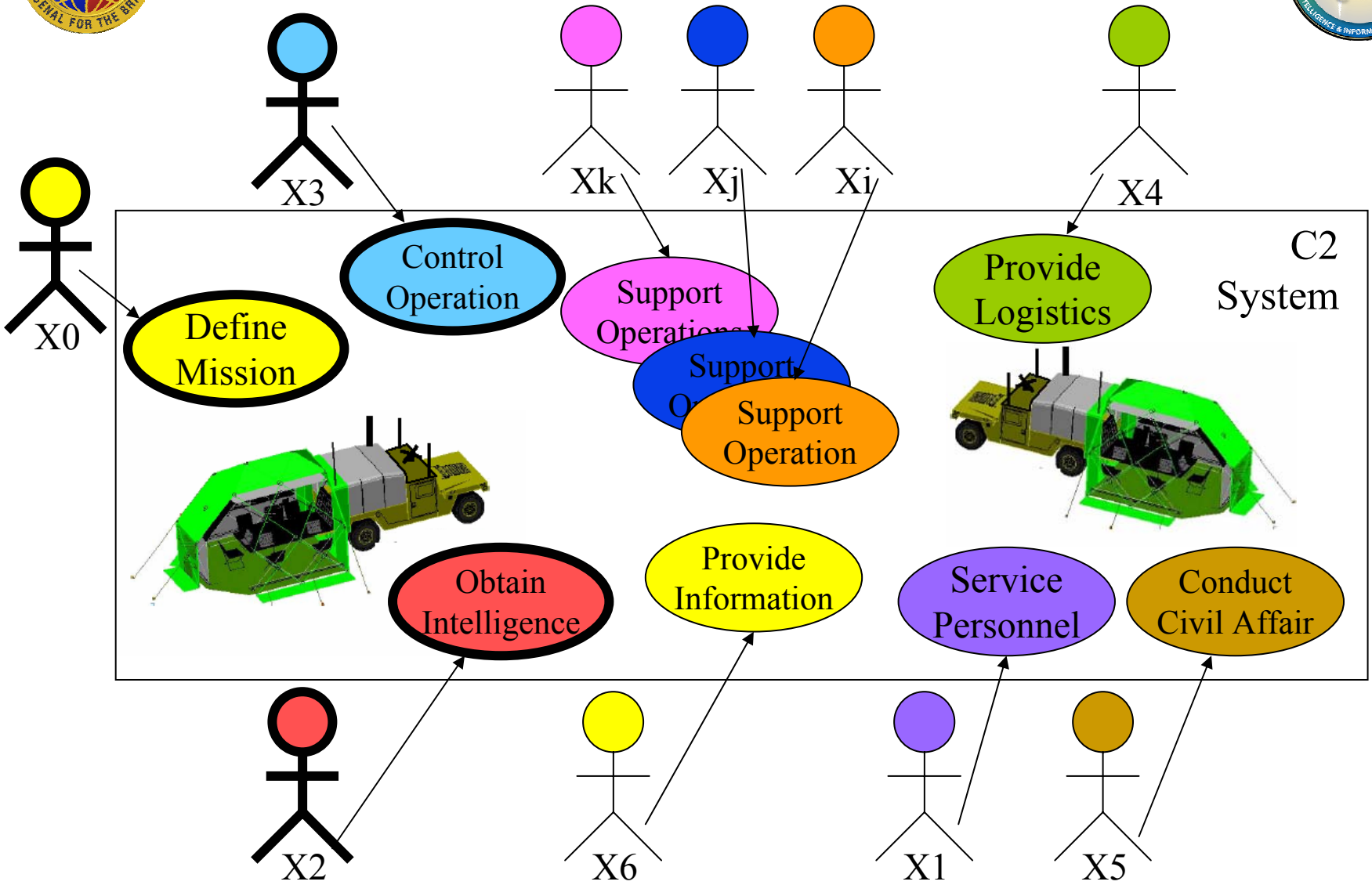
Collaborative Planning Decisions

Phases of Team, System, and Mission Execution Developments



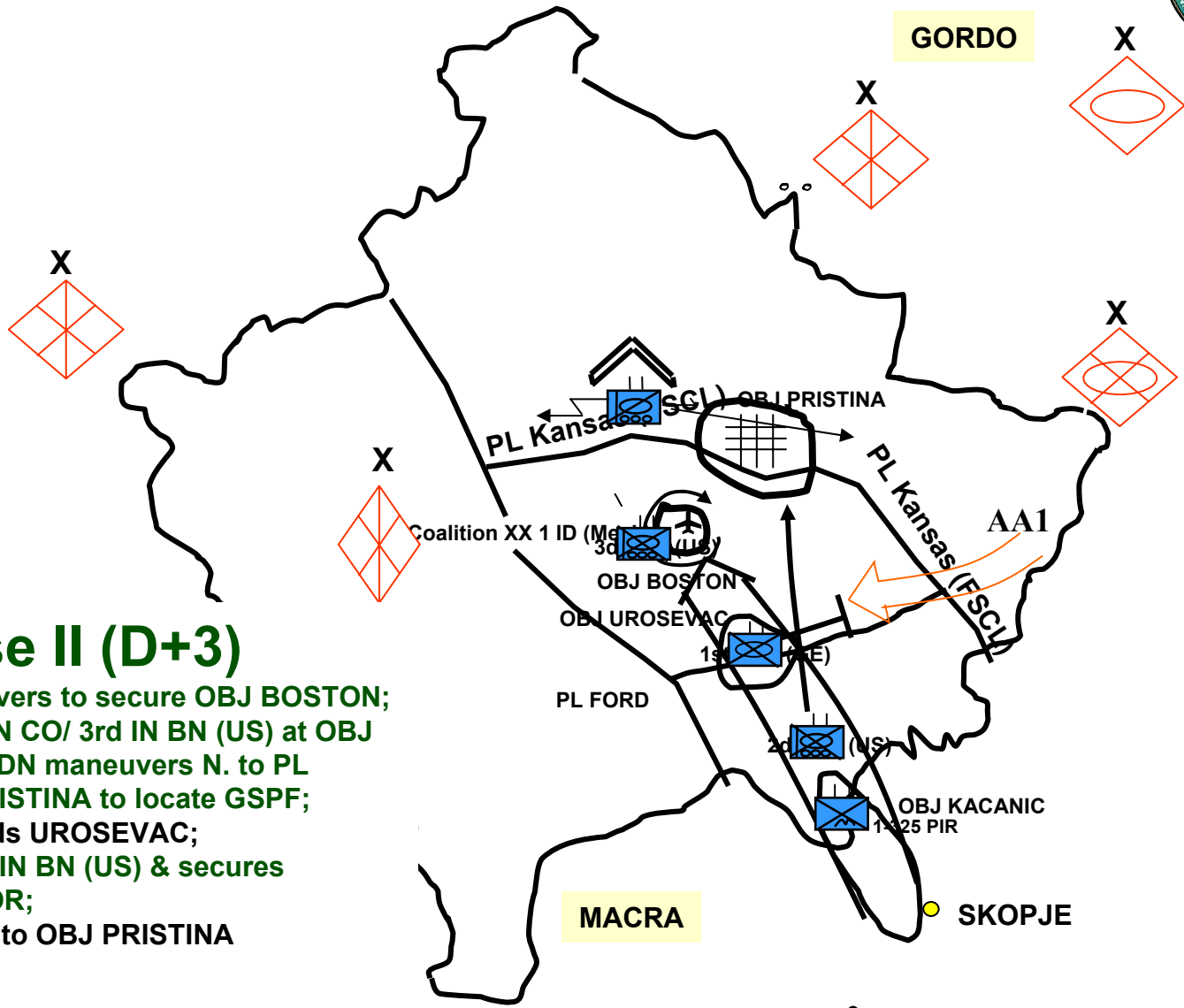
CECOM Bottom Line: THE WARFIGHTER

Experiment 1 - Operational Use Cases



CECOM Bottom Line: THE WARFIGHTER

Experiment 1 - Operational Scenario



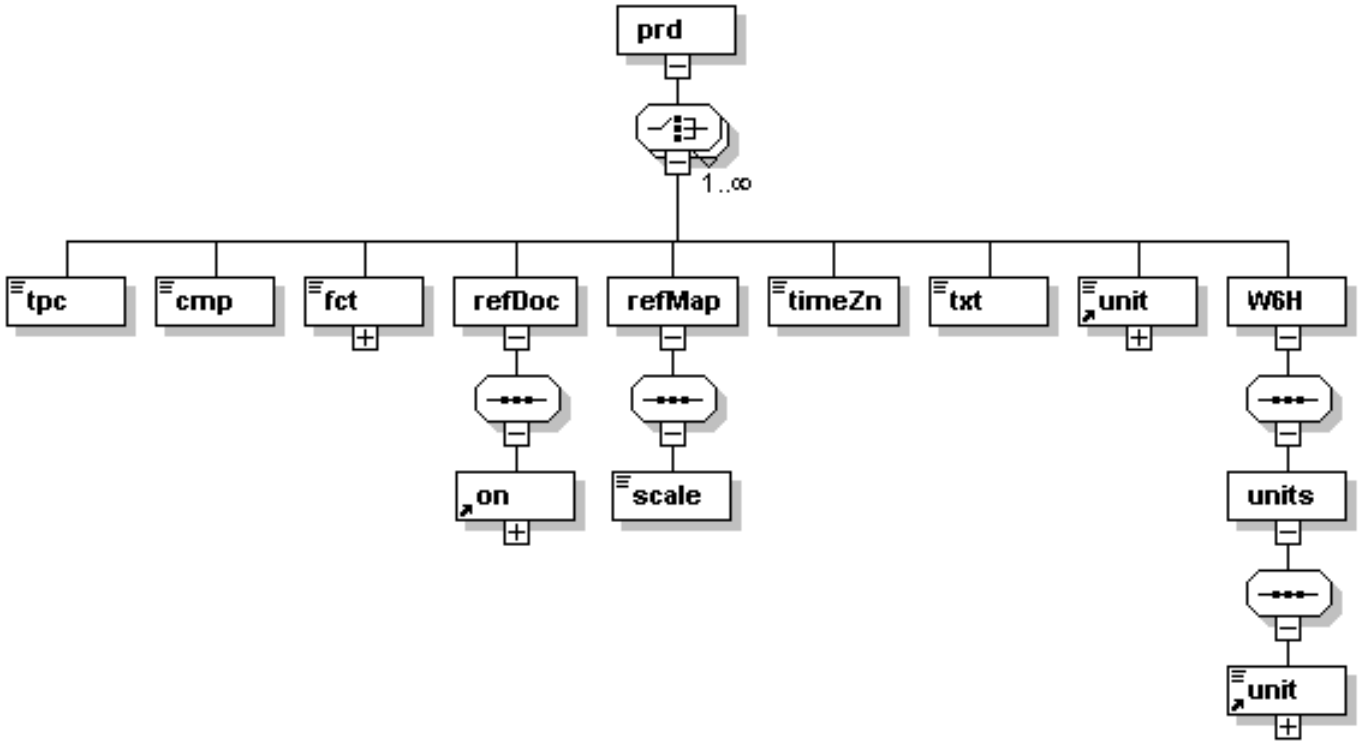
Phase II (D+3)

3d IN BN (US) maneuvers to secure OBJ BOSTON;
Upon closure of 1st IN CO/ 3rd IN BN (US) at OBJ BOSTON, RSTA SQDN maneuvers N. to PL Kansas and into PRISTINA to locate GSPF;
1st IN BN (GE) defends UROSEVAC;
1/325 PIR relieves 2d IN BN (US) & secures KACANIC CORRIDOR;
2d IN BN (US) moves to OBJ PRISTINA

C2 Product: - OPORD, Messages

- **Situation**
  - The Enemy Forces
    - Who are they? What kind of unit is it? What kind of Equipment do they have?
    - Where are they? How strong are they? Where are they effective?
    - How capable are they? What are they likely to do?
  - The Friendly Forces
    - What is our higher echelon mission and Concept of Operation? What is the mission of adjacent units?
- **Mission**
  - A clear concise, statement of what the unit is to do to include who,where, when, and why of the operation.
- **Execution**
  - What is the Concept of Operation? How to maneuver, how to fire, how to deal with obstacles? In Offense: what unit formations, movement techniques, routes of advance? On Defense: what battle positions to establish, weapon orientation, engagement plan, +more.
- **Service Support**
  - Where is refueling, How? Where is the collection point of damaged vehicles?
- **Command and Signal**
  - How communications will be maintained?
  - What is the command succession?

Experiment 1 – C2 Products



Generated with XMLSpy Schema Editor www.xmlspy.com

Experiment 1 – System States and Use Cases

- **Interconnection State**:
  - Interconnect Federate
- **Federation State**:
  - Enable Federate, Initialize Federate
- **Collaboration State**:
  - Collaborate with Coalition (to Plan Operation)
- **Interoperation State**:
  - Stimulate Federate,
  - Interoperate with Coalition (to Monitor Execution)

Typical OPORD Text Parsed by W6H Rules

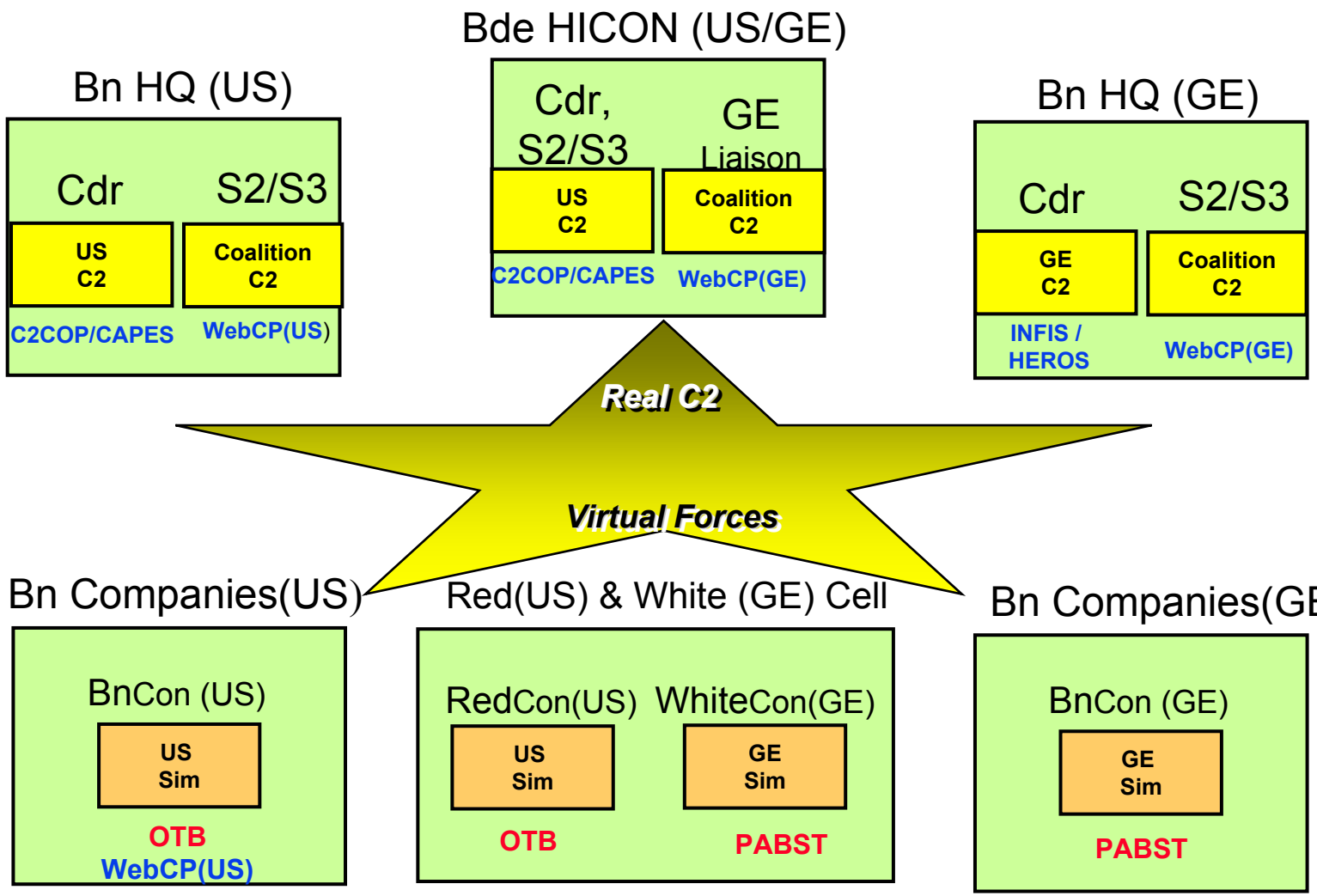
On order IBCT deploys to MACRAN REPUBLIC and moves immediately to Kazar to secure the KACANIC CORRIDOR, PRISTINA Airfield, and PRISTINA, and to establish a US presence throughout the zone. IBCT cooperates with KAF to defeat GSPF elements in zone and deters a Gordian attack on Kazar. If deterrence fails, IBCT defends in order to defeat GAF attack and to restore Kazarian territorial integrity.

Why	Who	Where	When	How	What	Which

OPORD Text represented in XML

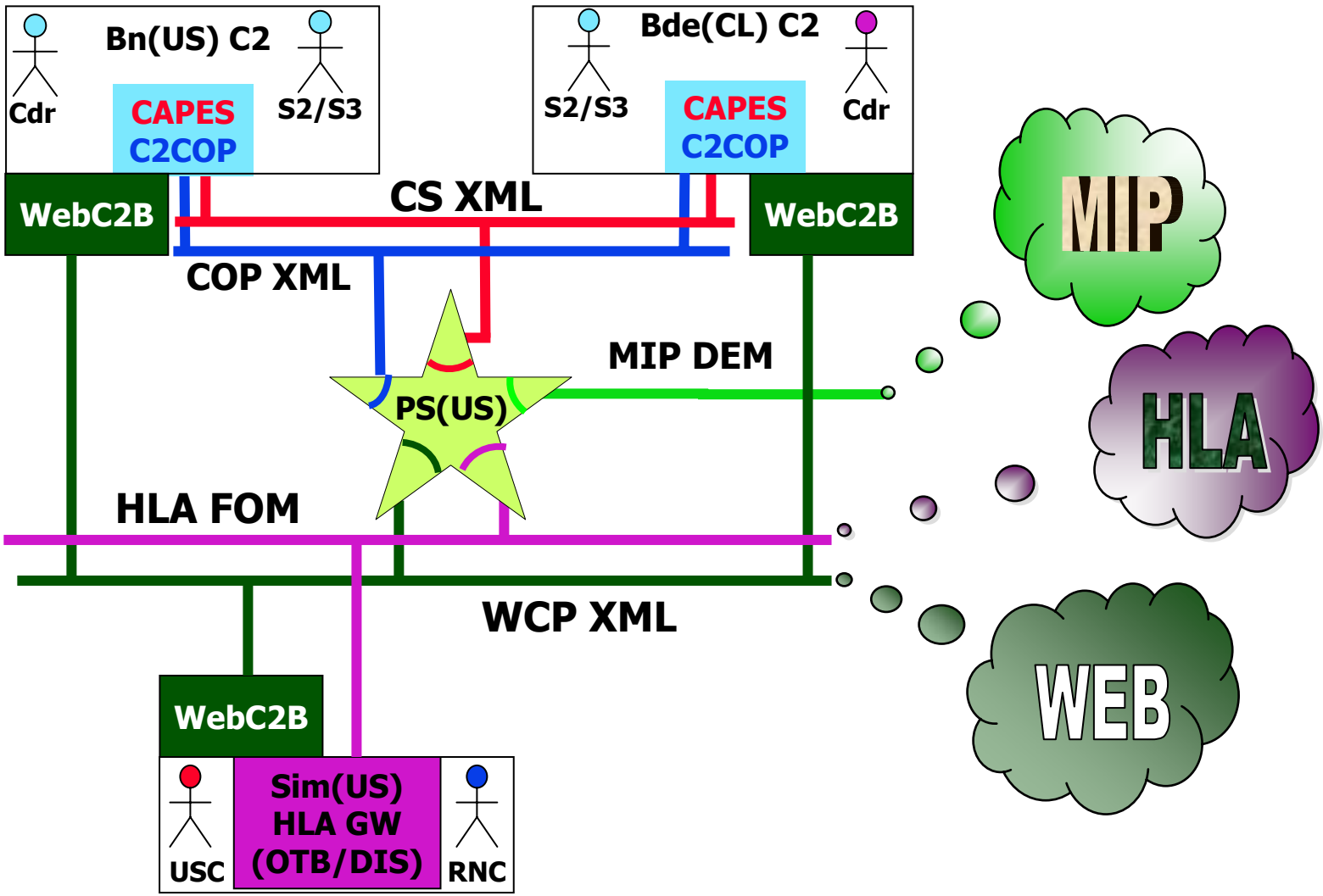
```
<?xml version="1.0" encoding="UTF-8"?>
<grp type="Situation/Friendly Forces" fnc="Mission">
<on type="order"><unit id="1st" role="IBCT" size="Bde" aff="Coalition"/><do type="mission">deploy</do>
<at type="state" name="Macran Republic"/><do type="mission">move</do><by type="rate">immediately</by>
<at type="region" name="Kazar"/><to>secure</to><at type="Corridor" name="Kacanic"/><to>secure</to>
<at type="airfield" name="Pristina"/><to>secure</to><at type="region" name="Pristina"/><to>establish</to>
<units aff="US"/><at type="zone" aff="Kazar"/><To>cooperate</To><Link><unit id=" KAF"/><To>defeat </To>
<unit id="GSPF" size="elements"/><at type="zone" name="Pristina"/><To>deter</To><Link><unit aff="Gordo"/>
<do> attack</do><unit aff="Kazar"/></Link><if><Link><unit aff="Gordo"/><do> attack</do><unit aff="Kazar"/>
</Link><then><do>defend</do><To>defeat</To><unit id="GAF"/><To> restore</To><unit aff="Kazarian">
<Status>territorial integrity </Status></unit></then></if></Link></on>
</grp>
```

Experiment 1 - Operational Configuration



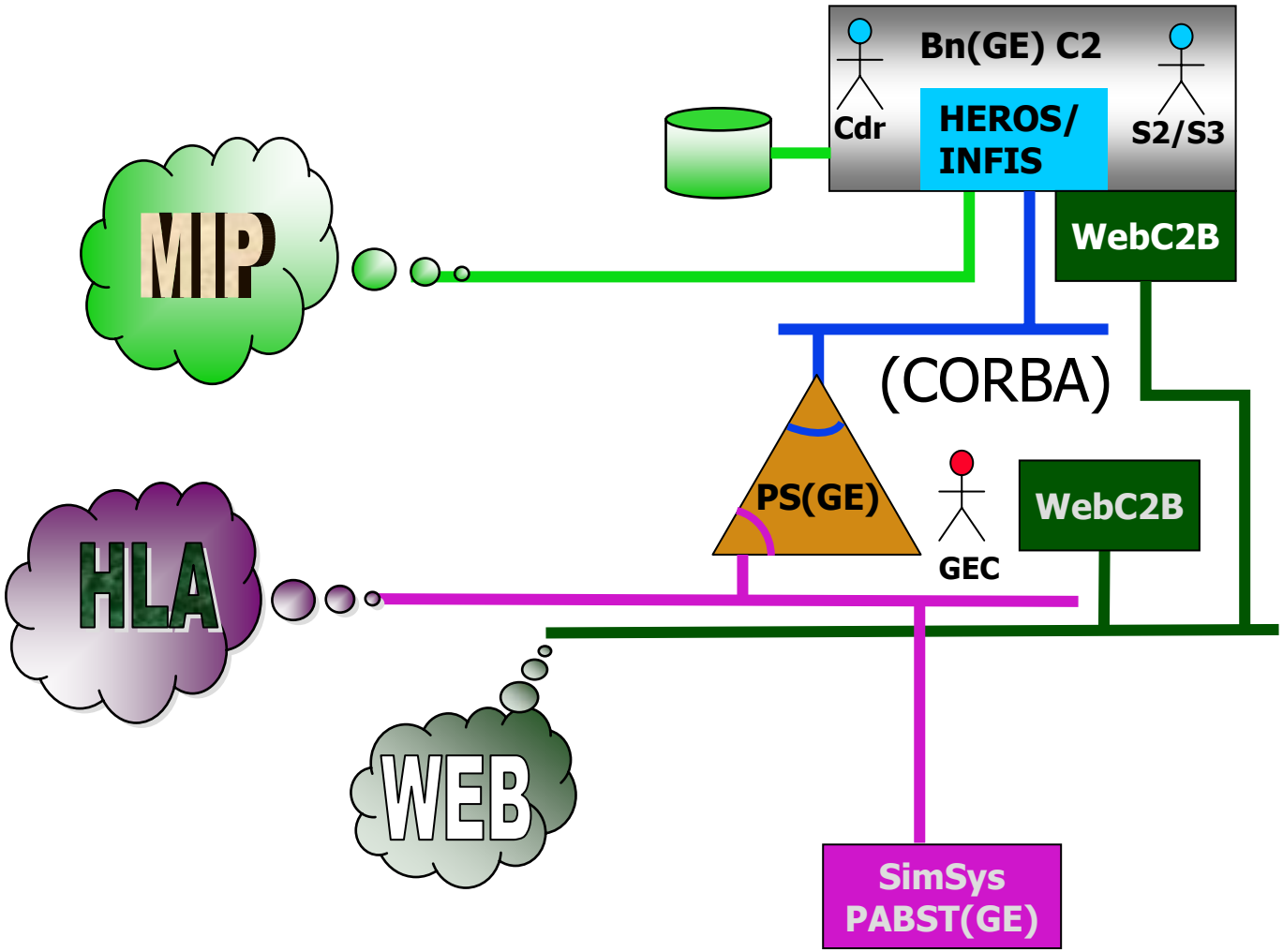
CECOM Bottom Line: THE WARFIGHTER

SINCE Experiment 1: US Environment



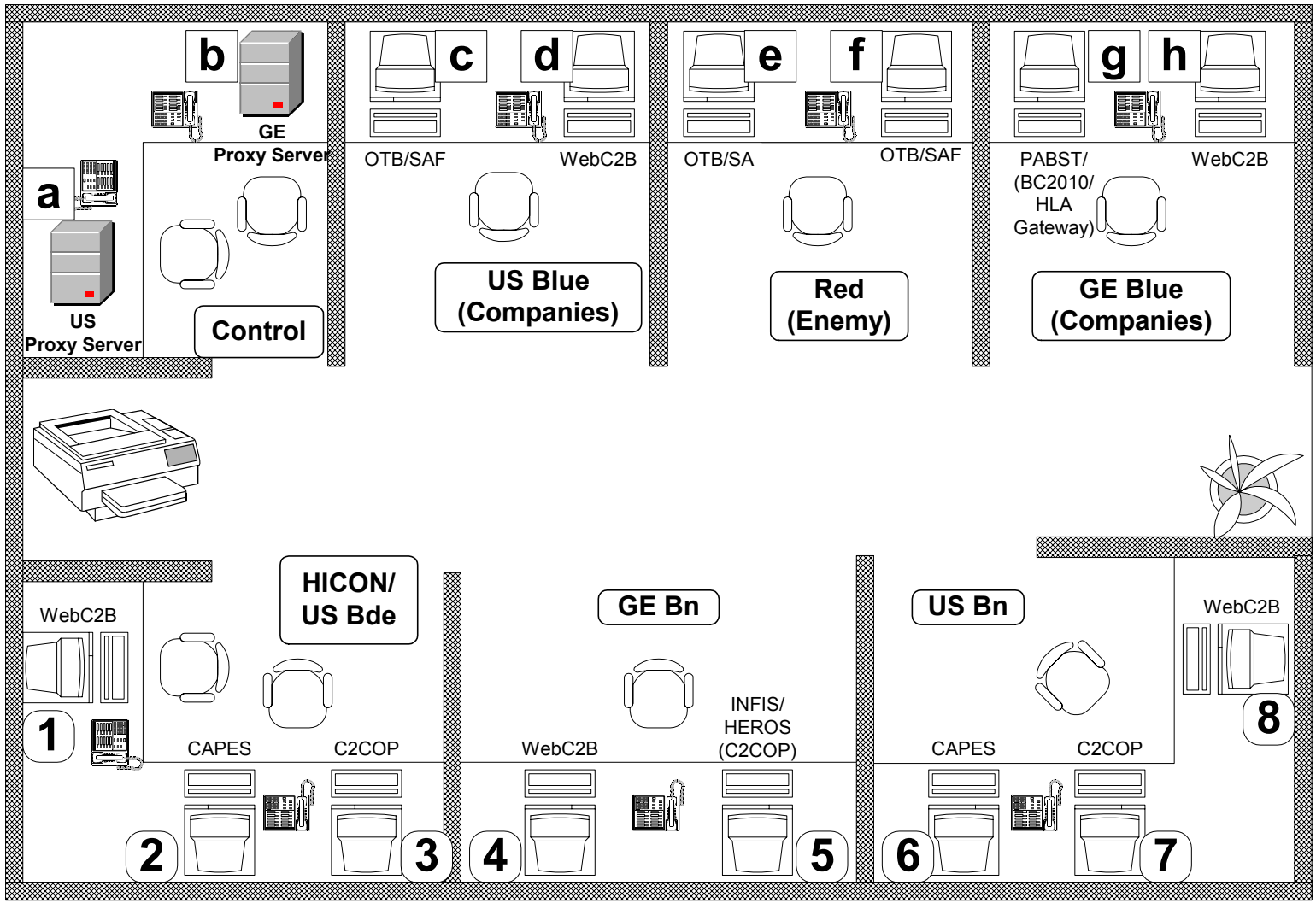
CECOM Bottom Line: THE WARFIGHTER

SINCE Experiment 1: GE Environment

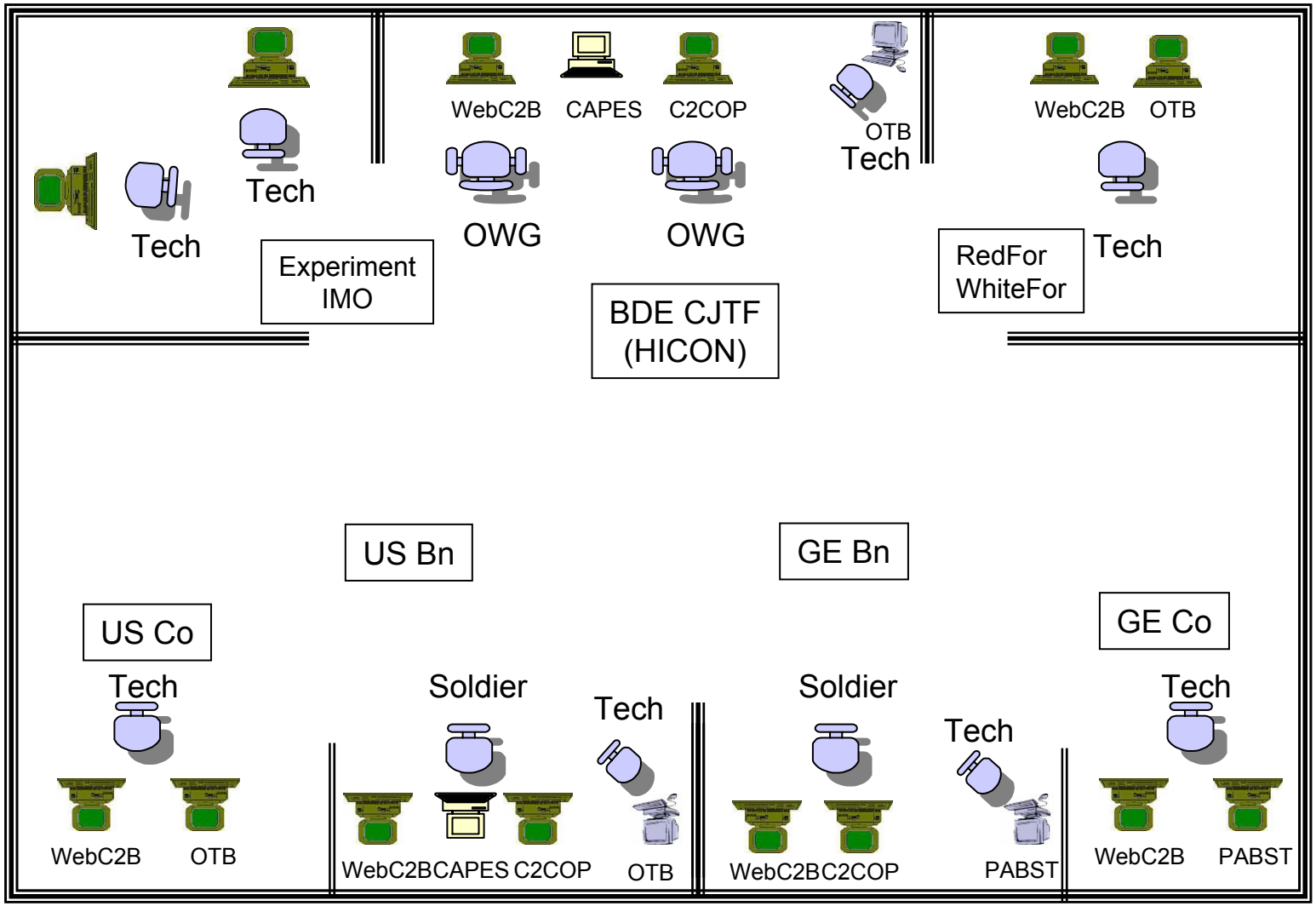


CECOM Bottom Line: THE WARFIGHTER

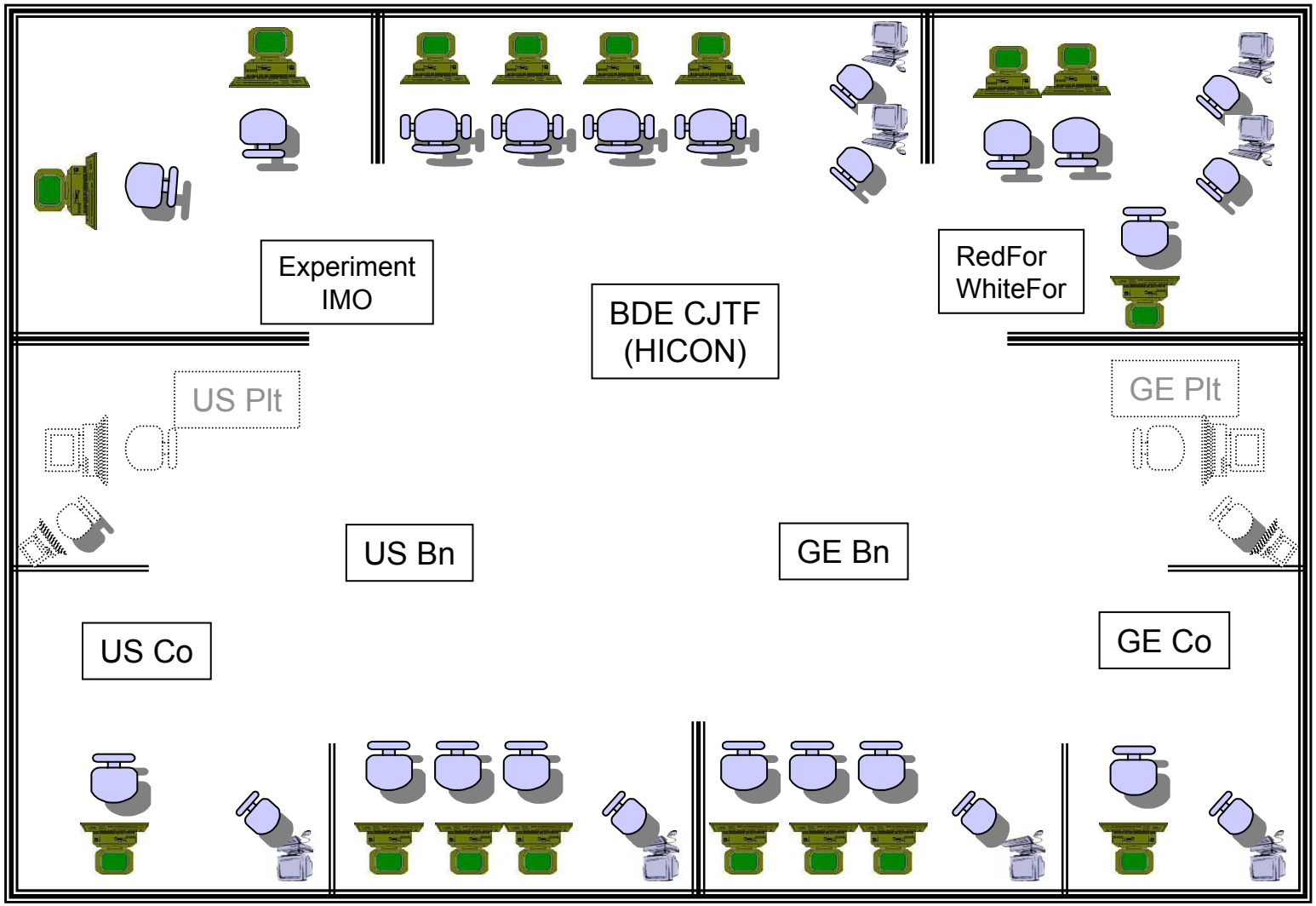
Experiment 1: Initial Configuration



Experiment 1a: Functional Configuration



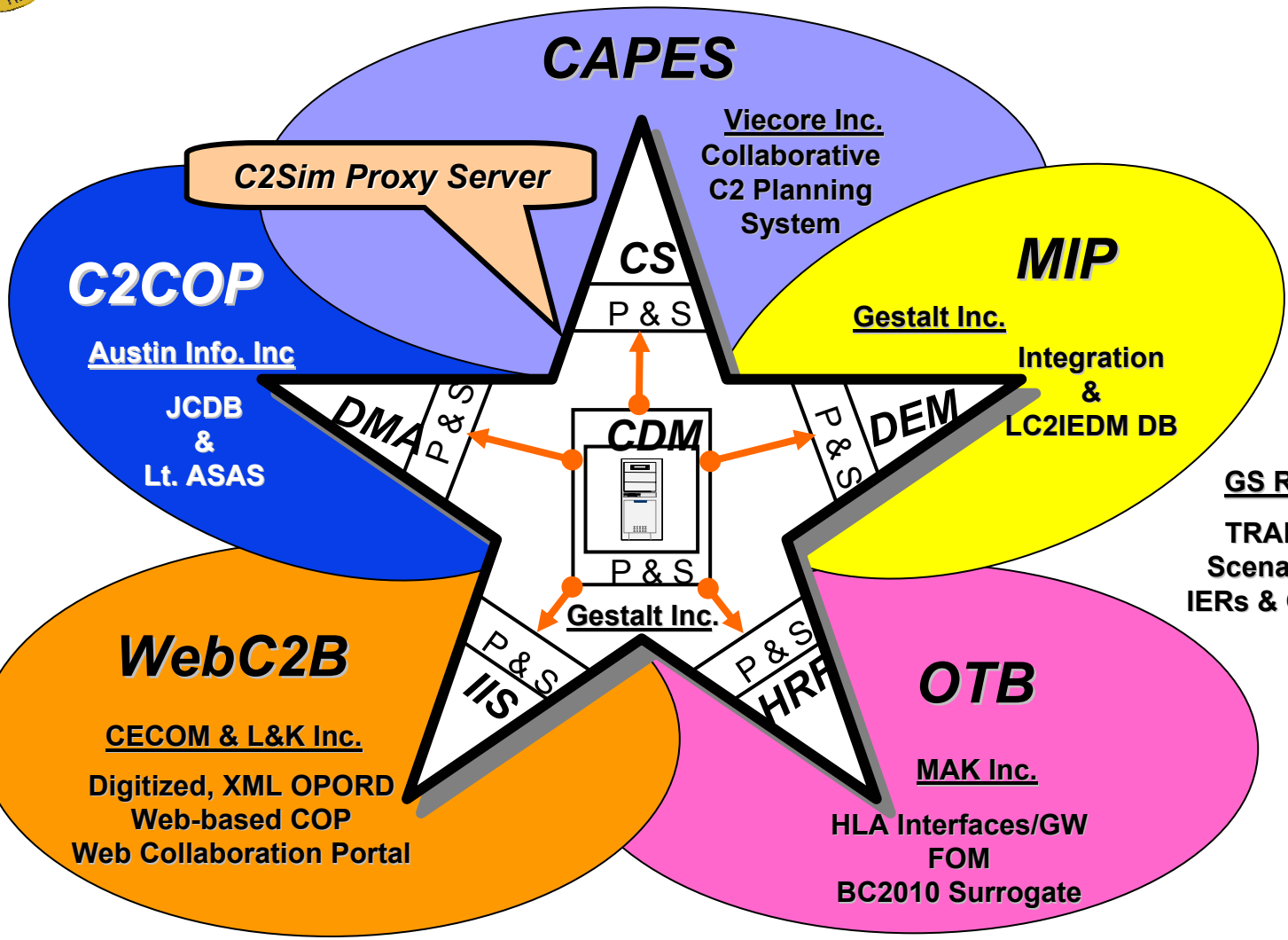
Experiment 1b: Operational Configuration



SINCE Information Exchange Mechanisms

- **Common Relevant Operating Picture (CROP) information exchanges between coalition C2 Systems:**
  - Exchanged via MIP LC2IEDM AdatP3 Messages or
  - **LC2IEDM database to database replication** mechanisms
- **Modeling and Simulation (M&S) Systems state information exchanges:**
  - Defined in the structure of HLA Federate Object Model
  - Exchanged **HLA RTI** Mechanisms
- **Real-time Tactical Planning Information exchanged between coalition force military planners and operations managers:**
  - Defined as **XML based text and graphics** constructs
  - Exchanged primarily via Web-based Collaboration Portal
  - Mapped into extended LC2IEDM/JDM database (planned)

SINCE C2Sim Proxy Server



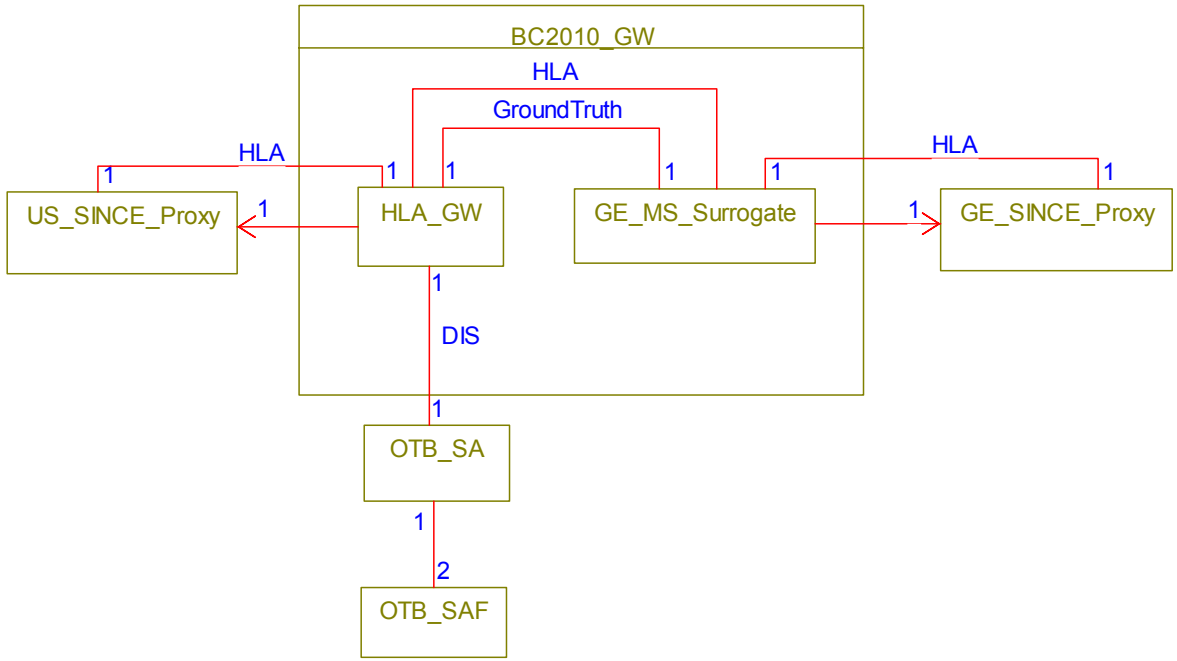
GS Research LLC

TRADOC Support
Scenarios, OPORDS
IERs & C2 Func. Rqmts

Object Model Diagrams: BC2010

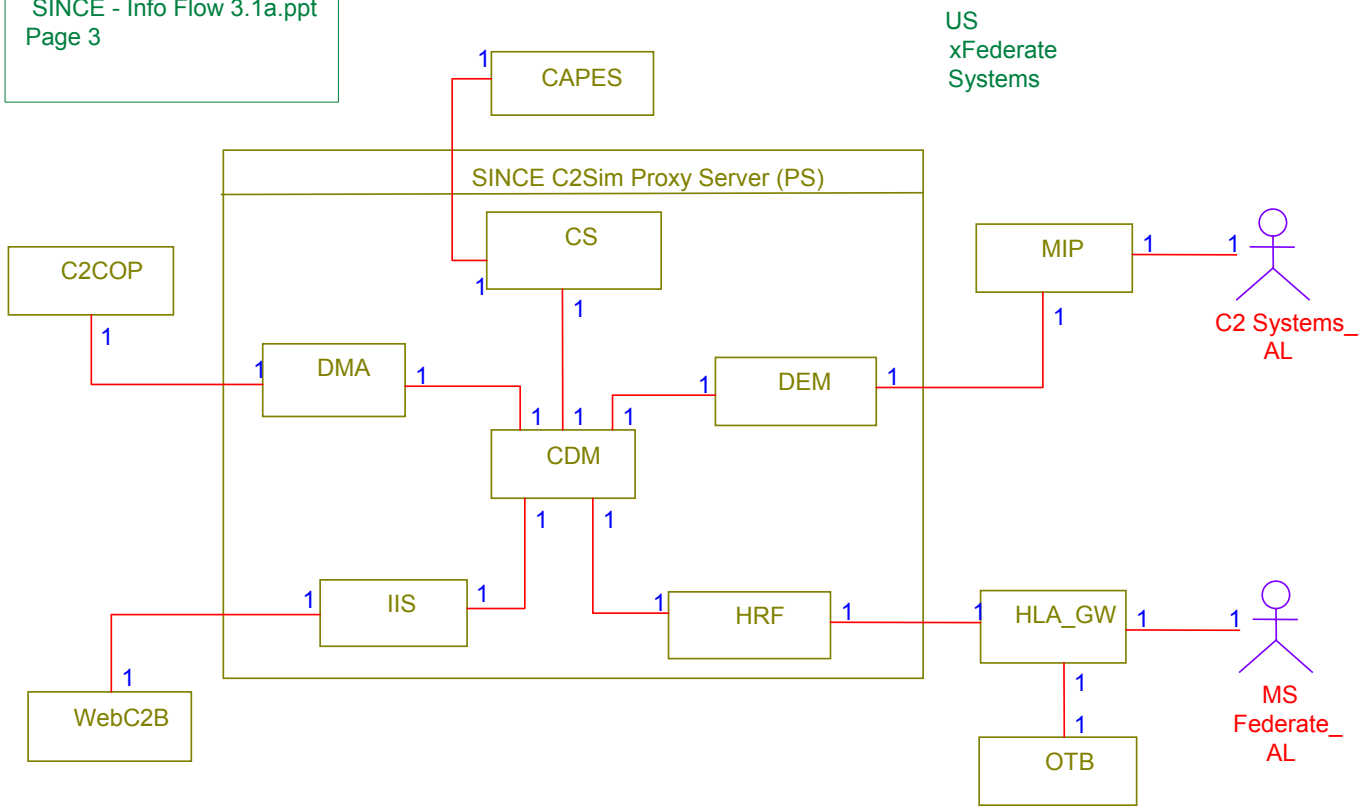
Source Document:
SINCE - Info Flow 3.1a.ppt
Page 2

BC2010/GW plays the roles of an Allied M&S surrogate and an OTB to HLA Gateway



Object Model Diagrams: SINCE C2Sim PS

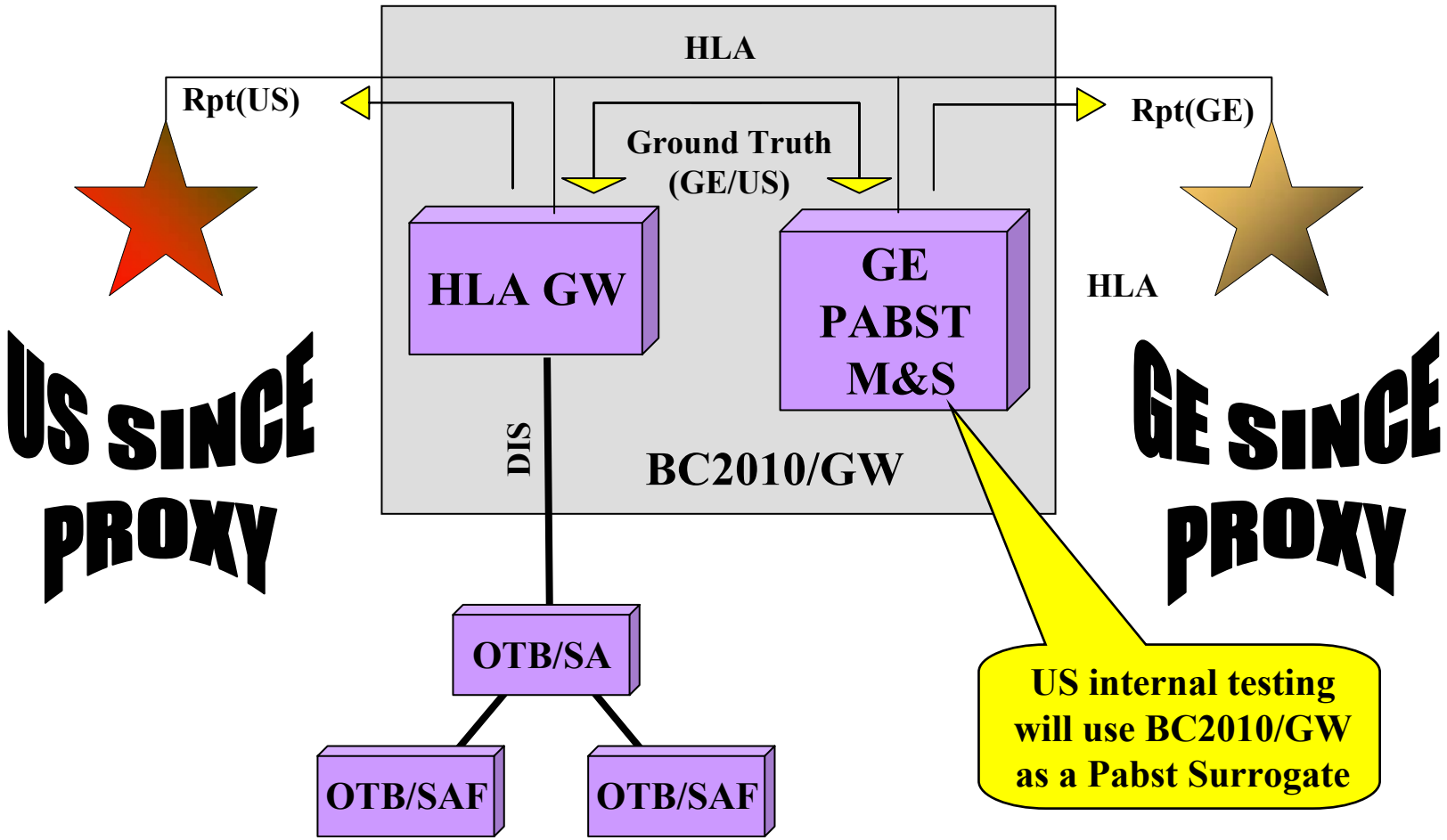
Source Document:
SINCE - Info Flow 3.1a.ppt
Page 3



C2Sim Proxy Server Acronyms

- CAPES - Combined Arms Planning and Execution System
- C2COP - C2 Common Operational Picture
- CDM - Coalition Domain Manager
- CS - Collaboration Server
- DEM - Data Exchange Mechanism
- DMA - Data Model Adapter
- HRF - High Level Architecture Real-time Infrastructure Reference Federation Object Model
- MIP - Multilateral Interoperability Program
- OTB - OneSAF Test Bed
- P&S - Publish and Subscribe Mechanism
- WebC2B - Web C2 Browser, Web Portal

SINCE Interface of US and GE M&S

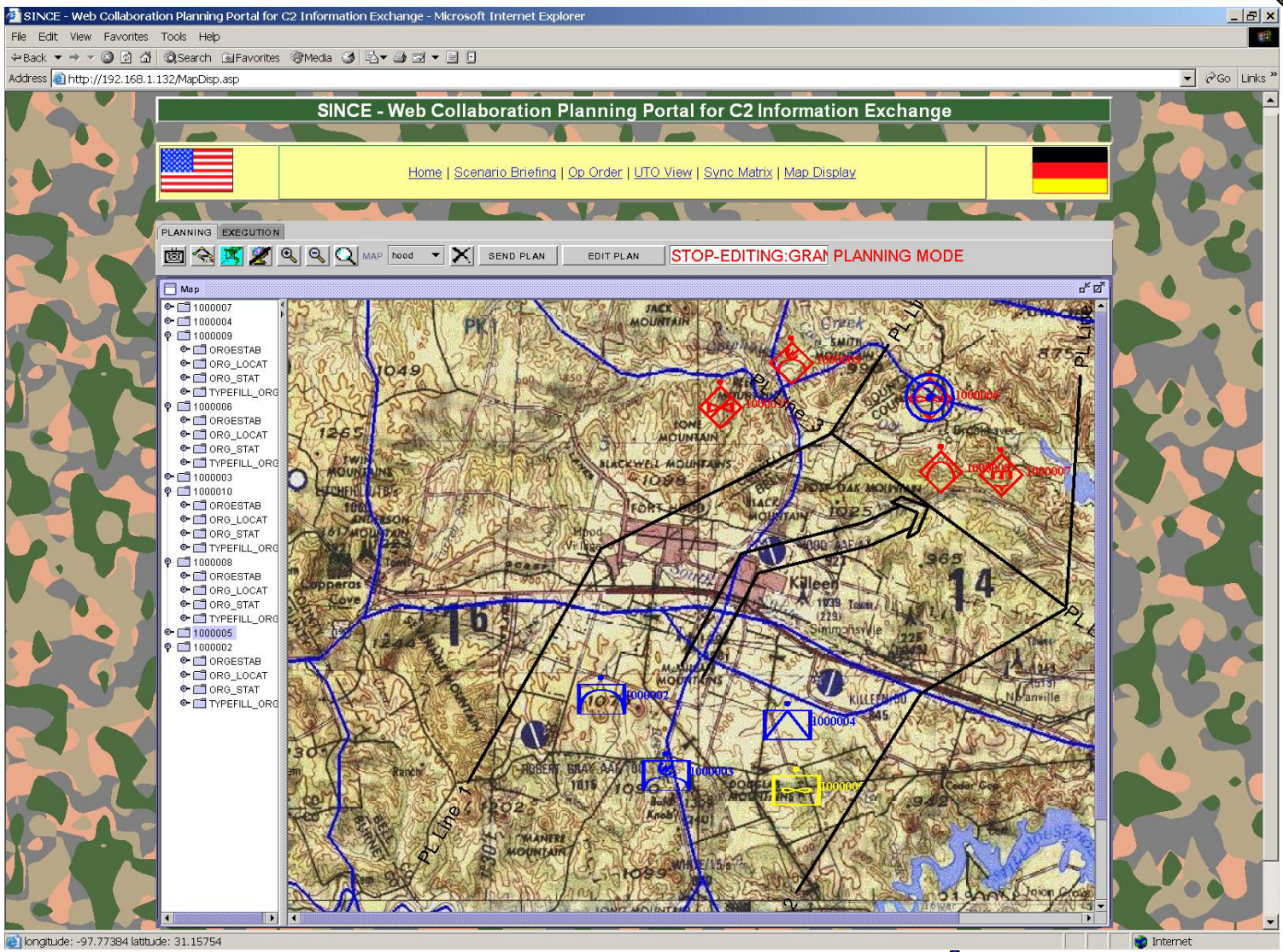


Web-based Collaboration Portal Exchanges

Supports real-time situation visualization and planning concept information exchanges by

- Enabling coalition force planners to jointly view the evolving operational picture
- Supporting the exchange of visual battlefield and operation graphics information during a planning session
- Supporting the generation and display of coalition force Operational Orders, Frago's and Task Force Synchronization Matrix information via common XML-based constructs
- Implementing a common agreed upon set of terms, tactical phrases and battle management language/concepts for exchange of textual planning information that assure consistent execution of coalition operations.

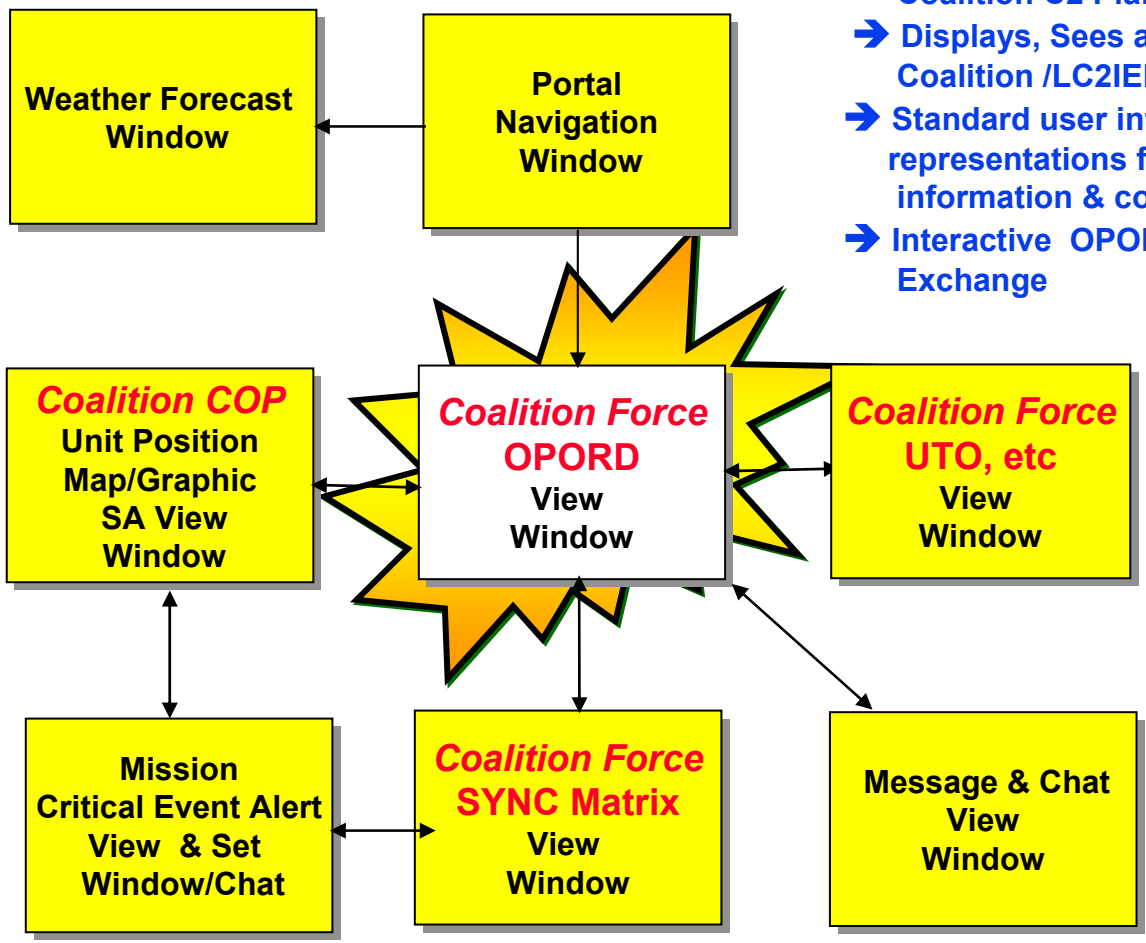
Web-Based Collaboration Portal (WCP)
View of the Coalition CROP



CECOM Bottom Line: THE WARFIGHTER

The Web-based Collaboration Portal (WCP)

- Gateway between National & Coalition C2 Planning Systems
- Displays, Sees and Operates on only Coalition /LC2IEDM Information
- Standard user interfaces & information representations for exchange of planning information & concepts (BML, Graphics,etc)
- Interactive OPORD building and Info Exchange

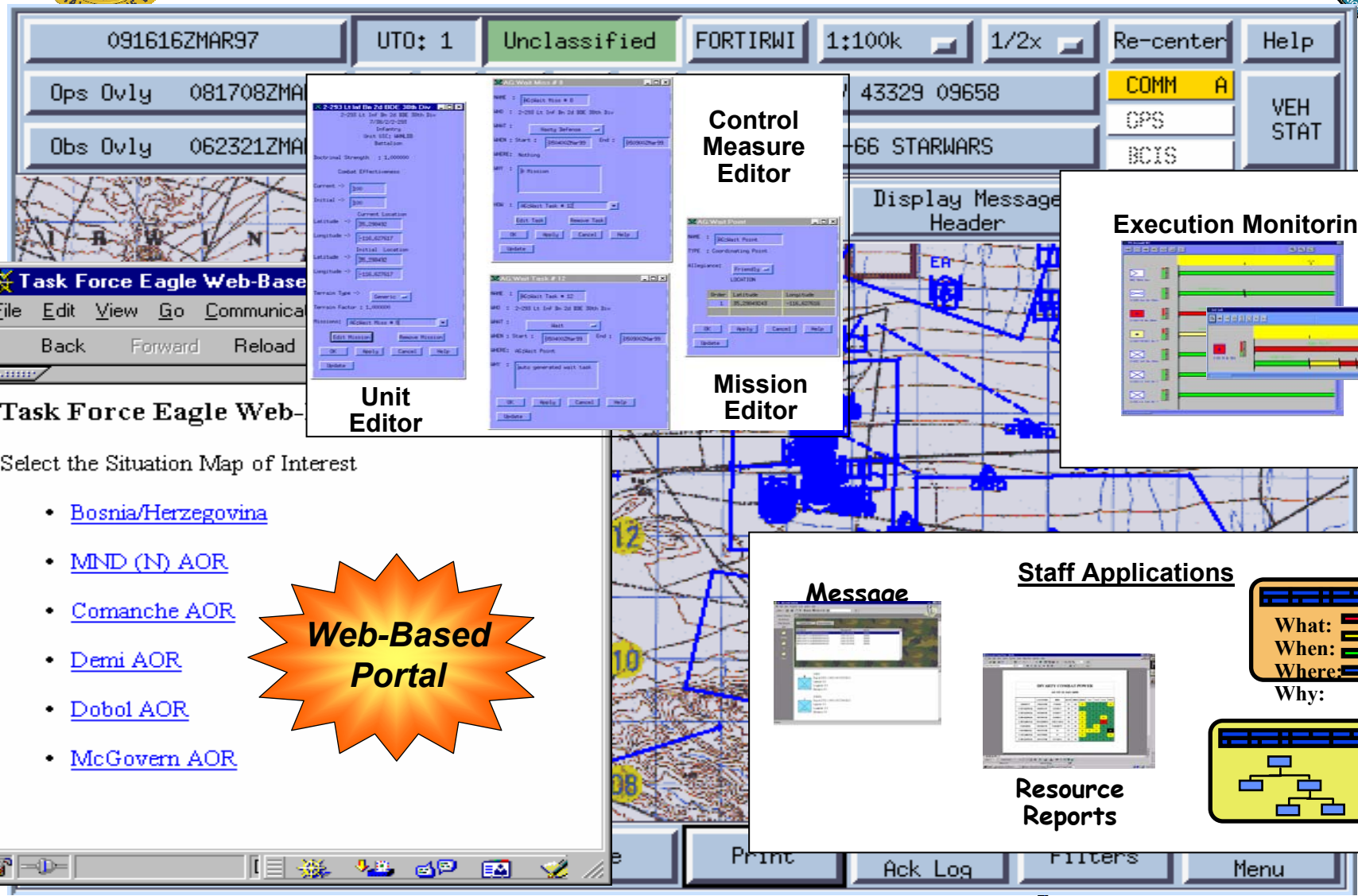


SINCE WCP Interactive OPORD Development
(Collaboration & Common Battle Command Language)

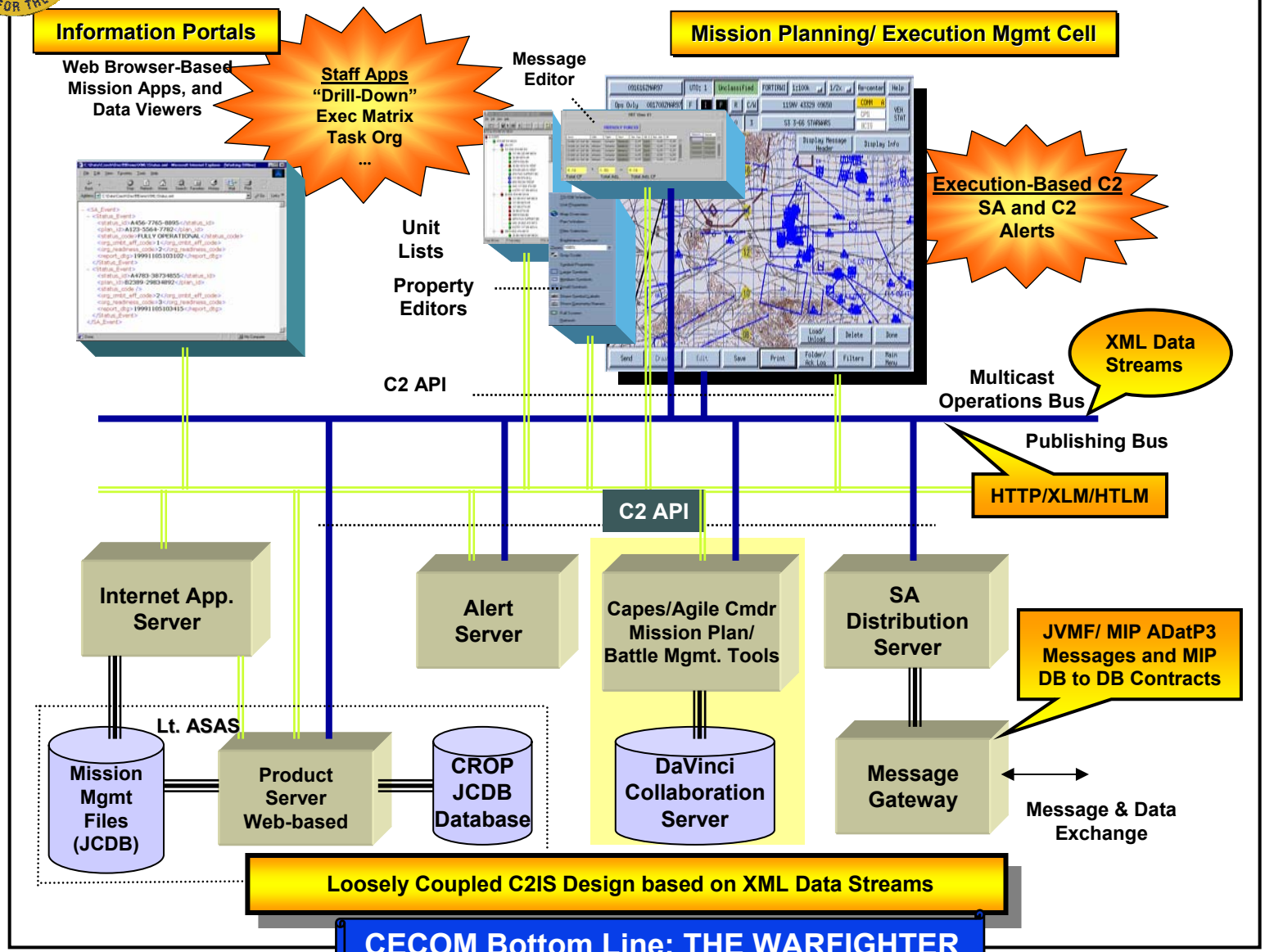
To facilitate the interactive development of a coalition OPORDs using Web-based technologies and standards we are

- **Using XML documentation specifications and constructs**
- **Creating XML document instances via core XML Specifications (Style/Schema)**
- **Parsing natural language OPORD text and graphics in terms of a *Battle Command Language* using a W6H Reference Model**
- **Formalizing a common coalition ontology that will enable common understanding of OPORD tasks, missions, concepts, etc. by coalition partners**
- **Appling this ontology to support interactive collaboration**
- **Using the planning ontology and XML constructs developed under the Agile Commander/CAPES efforts**
- **Also coordinating with SIMCI on their BML and C4ISR reference model development effort and leverage as it becomes available**

WCP Supports Real-Time Collaboration & Info Exchange between Coalition Force Planners



US Emulated Objective Force & FCS C2 Systems



Combined Arms Planning & Execution Monitoring System (CAPES)

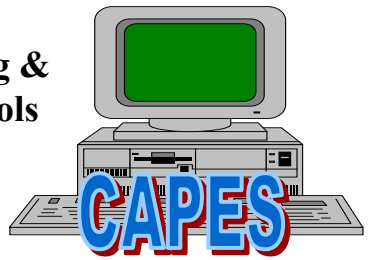
CAPES – C2 Toolset enabling the commander and staff to rapidly and effectively plan/monitor/replan combined arms (e.g. maneuver, fires, logistics) operations

Planning

- Mission Analysis
- COA Development
- COA Analysis
- COA Comparison
- COA Approval
- Orders Generation

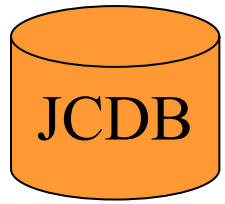
Military Decision Making Process

Automated Reasoning & Decision Support Tools



Execution Monitoring

Tactical Picture & Execution Alerts



Monitor Joint Common Database for Plan Contingencies

Visualization & Collaboration

- Map Background
- Mil Std Graphics
- COA animation

- Horizontal Plan Collaboration
- Vertical Plan Collaboration

FY 03 SINCE Tasks

- **Task1: Experiment 1 Program Management and Schedule Tracking**
  - Program execution management, milestone & schedule tracking, documentation
- **Task 2: SINCE C2Sim Proxy Server Development**
  - Expand capability of Feasibility Prototype to meet Experiment 1 needs
  - Multiple types of MIP C2 message, LC2IEDM DB replication data contracts, M&S HLA Object data and Plan graphics/overlay information exchanges
- **Task 3: Command & Control (C2) Planning Cell Definition and Implementation**
  - Integration of C2 systems & software to meet Experiment 1 needs
  - Expand capability of Web-based Collaboration Portal (WCP) Prototype to support Mission Planning/Mgmt. Information Exchange needs of Experiment 1
- **Task 4: Operational Working Group (OWG) Documentation Dev. Tasks**
  - Define Experiment 1 Operational scenario, functions & testing requirements
  - Develop Operational Implementation Plan and Operational Test Plan
- **Task 5: Technical Working Group (TWG) Documentation Dev. Tasks**
  - Define Technical Implementation Concept, requirements and architecture
  - Develop Technical Implementation Plan, Integration Plan and Test Plans

(Tentative SINCE Technical Experiment 1a Target Dates - Nov 2003)

(Tentative SINCE Operational Experiment 1b Target Dates - Apr 2004)

Key FY 03 SINCE Products/Effort Timelines

Documentation Products

- US/GE SINCE Project Agreement *(Signed -11/24/02)*
- Program Implementation Plan & Schedule
  (PIP approved 11/15/02, Schedule revised 4/31/03)
- Operational Implementation Plan (OIP) *(7/1/03)*
- Operational Test & Evaluation Plan (OTEP) *(9/8/03)*
- Operational Experimentation Plan (OEP) *(8/8/03)*
- Technical Implementation Plan (TIP) *(8/11/03)*
- Technical Test & Evaluation Plan (TTEP) *(10/6/03)*
- Technical Experimentation Plan (TEP) *(9/8/03)*
- Program Security Instruction *(Approved– 4/31/03)*
- Technical Experiment 1A Final Report *(12/16/03)*
- Operational Experiment 1B Final Report *(6/8/04)*

Technical & Experiment Support Activities

- C2Sim Proxy Server Implementation & Info Exchange Interoperability Testing (US)
  (Integration- 6/9-8/4/03; Testing-8/5-8/25/02)
- C2 Cells & WCP Implementation & Functional/Interoperability Testing (US)
  (Integration ; 6/9-8/28/03 Testing- 8/29-9/26/03)
- Experiment 1A Combined US/GE Technical Integrated Systems Testing *(11/10-11/13/03)*
- Experiment 1B C2 Cell & M&S Sys. Operator Training *(3/4-3/12/04)*
- Conduct of Technical Experiment 1A
  (Greding, Germany) *(11/10-11/21/03)*
- Conduct of Operational Experiment 1B
  (US- TBD maybe Trans-Atlantic) (4/19-4/29/04)
- Dignitary Briefing and Demonstration
  (4/30/04)

Summary and Conclusions

- **The goal of SINCE is to demonstrate and transition a Collaborative Suite of C2 Support Tools that:**
  - **Capable of supporting coalition force operations (across conflict spectrum)**
  - **Compliant with evolving network centric, Objective Force/FCS concepts, tactics, techniques and procedures (TTP), doctrine, architecture & Army DII-COE.**
  - **Integrate/incorporate use of real-time CROP Situation Awareness (SA) and collaboration to promote better, common understanding of an Operation's execution between coalition force partners.**
  - **Demonstrate/evaluate interface mechanisms that enable C2 Information systems to use M&S systems in support of Coalition-Force COAA and Mission Rehearsal**
- **Provide prototype, "state of the art", Web/XML based Information Portal capability enabling/ supporting exchange of real-time CROP SA, planning and battle management information with coalition Partners having nation-specific C2I systems**
- **Refine Coalition Force Operational Procedures and experience with alternate and new ways of achieving interoperability**

SINCE Project Synopsis

- **OVERALL OBJ ECTIVE:**
  - **Refine, experiment and demonstrate improved collaborative C2 Mission Planning & Mgmt Decision Support Tools tuned to support "On the Move" coalition operations.**
  - **Develop and demonstrate interoperable Web-based Coalition COP Info Exchange and Collaboration capabilities tuned to support SASO & Peace Keeping Ops.**
  - **Develop and demonstrate a Web-based, Xml-oriented, digitized OPORD/FRAGO information exchange tool supporting continuous coalition collaborative planning activities using a common Battle Management Language ontology.**
  - **Implement a reusable, flexible, cost-effective R&D network of C2I, M&S, & Decision systems designed to support Coalition Ops concept evaluation, experimentation and mission rehearsal activities.**
- **PRODUCTS: Suite of Collaborative, Web-based C2 Collaboration, Information Portal and C2Sim Proxy Server software for exchange of Coalition Common Operating Picture (CCOA) situation awareness and Demo of Common C2I & M&S systems info exchange interface for support of multi-nation experiments.**
- **OUTPUT/EXIT CRITERIA: Experiments demonstrating better, faster, more accurate Coalition Ops decision support, current is manual; goal fully automated; minimum is greater than 50% automated. Incremental ATD & PEO software drops every 18 months**

C2D PROJECT TEAM:

US PROGRAM MGR: Dr. Dirk R. Klose
PROJ ENGR: Dr.Mayk, H. Negaran, A. Chan, J. MAI, G. Kainz
M&S ENGINEER: Greg Ilaria
PLATFORM/INTEGRATION ENGR: NA
PROTOTYPING ENGR: NA
POWER ENGR: NA
FINANCIAL REP: Ms. Mary Mellone

Outside CECOM Team Members:

TRADOC:
MMBL (Ft. Knox): David Estes
BCBL (Ft. Leavenworth): Col Hiemstra
Support Contractors:
- **Gestalt Inc.(C2Sim Proxy Server Integration)**
- **LNK Corp with Austin Info Inc. (C2 COP)**
- **Mak Inc. (M&S HLA Support/Integration)**
- **Viecore Inc. (Capes & C2 System Implementation**
- **Farance Inc & I-Logic (Web Doc/UML Support)**
- **GS Research LLC(Karl Gunzelman & Langston BCBL/MMBL Support)**

Backup Slides

SINCE Program Focus and Goals

The focus of US/GE SINCE experimentation activities:

- Conduct of **Collaborative Mission Planning and Execution Management** activities as needed to support Objective Force/FCS coalition force operations at the Brigade and **Battalion** levels.
  - ⇨**Improved Information Exchange and Situation Understanding leveraging evolving solutions e.g. MIP, LC2IEDM, etc.**
  - ⇨**Streamlined Decision Making Process for Coalition OPs**
- Demonstrate **Common International Information Exchange Interface** supporting connection of C2 Information Systems (C2IS) and Modeling and Simulation (M&S) systems used in experiments
- **Integrate M&S into** the Coalition OPs **Decision Making Process**

SINCE Operational Program Goals are to:

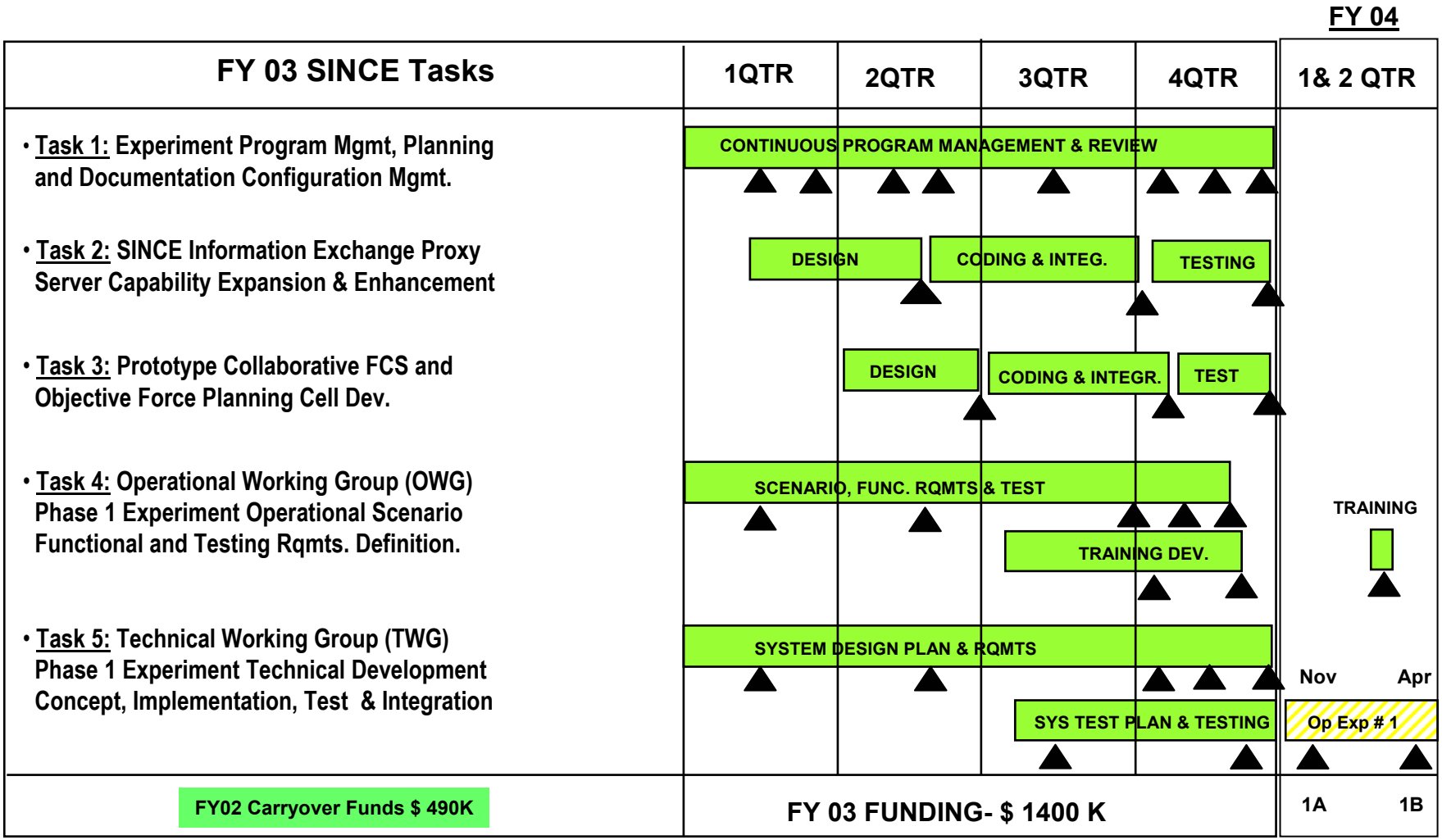
- Provide Coalition Force Commanders with improved means for
  - ⇨**Visualizing and Understanding the Coalition Battle Space**
  - ⇨**Conducting Collaborative Ops Management Activities**

Significant FY03 Accomplishments

- ***US/ GE SINCE Project Agreement***
  - Mr. Craig Hunter, Deputy Assistant Secretary of the Army for Defense Exports and Cooperation, OASA(AL&T) signed Agreement 26 Sept 02.
  - Dr. K. Schoenback, Präsident IT-Amt BWB, signed agreement on 25 Nov 02
- ***US/GE SINCE Program Security Instruction (PSI)***
  - SINCE Program Security Instruction was completed during the 28-31 Apr 03 PMG Meeting and sent out for national staffing
- ***Program and Milestone Schedule***
  - Revised Program and Milestone Schedule was approved 28-31 Apr 03 PMG Meeting
- ***SINCE C2Sim Proxy Server***
  - SINCE Experiment 1 C2Sim Proxy Server Implementation Concept approved 28-31 PMG Meeting
- **TWG & OWG *defined SINCE Experiment 1 Technical Test Bed Configuration***
  - SINCE Technical Experiment 1A Test Bed Configuration approved 28-31 PMG Meeting
- ***Operational Implementation Plan (OIP) & Scenario for Experiments 1A & 1B***
  - PMG approved current draft and directed final, completed product be delivered 31 June 03
- ***Detailed XML tagged representation and data mapping*** of MIP/LC2IEDM ADatP3 messages and the Coalition OPORD completed. M&S ***HLA FOMS mapping*** is still in progress.
- ***SINCE Web-based Doc*** went operational May 03.

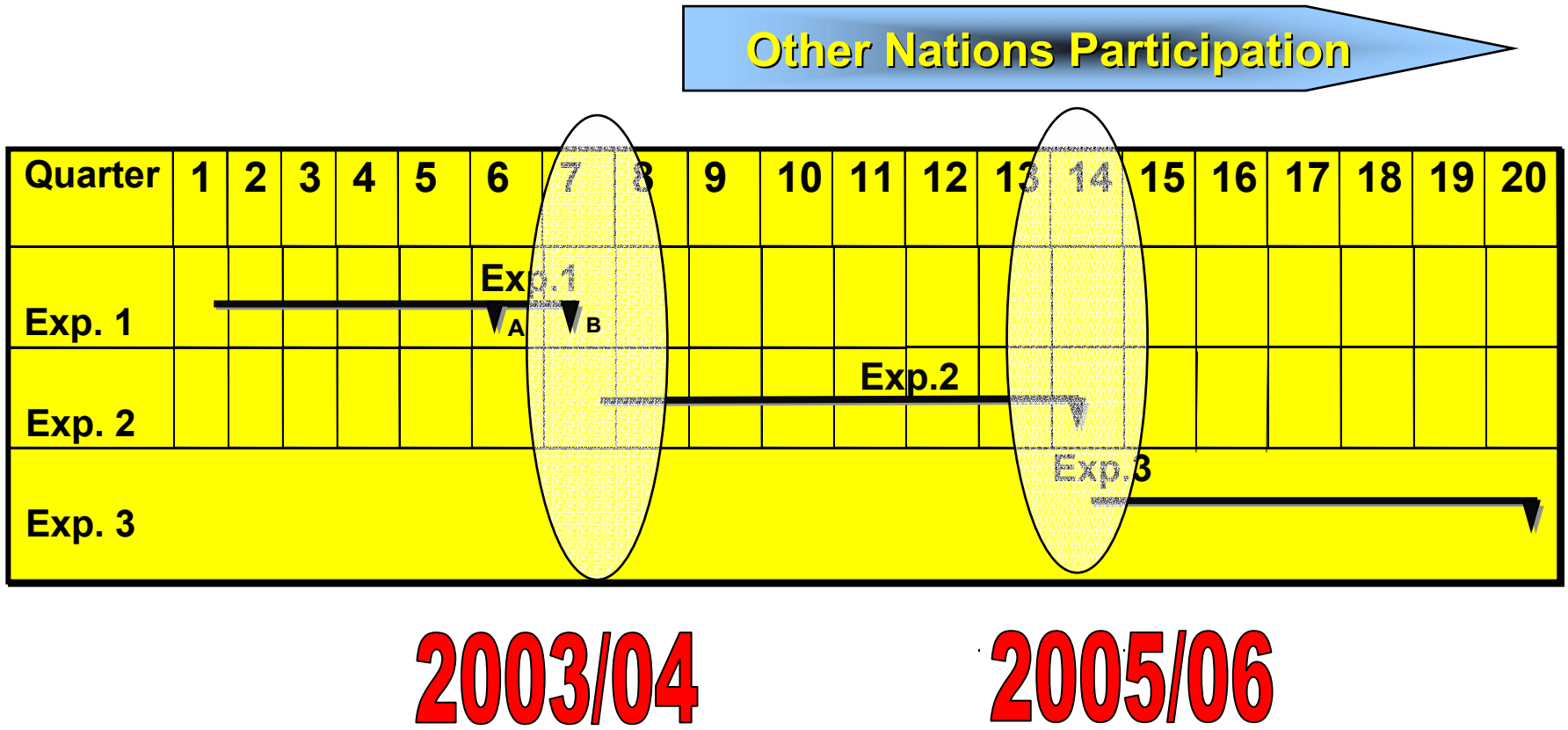
SINCE Task Execution Schedule

FY 03 SCHEDULE AND COST



CECOM Bottom Line: THE WARFIGHTER

SINCE Experiment Schedule & Perspective



CECOM Bottom Line: THE WARFIGHTER

Summary and Conclusions

- The goal of the US is to demonstrate and transition to PEO C3S, ABCS PMs, FCS and Objective Force C2I System PMs a Collaborative Suite of Mission Planning, Execution Assessment, Dynamic Re-Planning and Decision Support Tools that:
  - ⇨ Have been harmonized and validated to support coalition force operations (Both Traditional and Stability and Support Operations)
  - ⇨ Compliant with evolving network centric, Objective Force/FCS Mission Planning, Execution & Battle Management concepts, tactics, techniques and procedures (TTP), doctrine, architecture & Army DII-COE
  - ⇨ Integrate/incorporate use of real-time CROP Situation Awareness (SA) and collaboration to promote better, common understanding of an Operation's execution between coalition force partners
  - ⇨ Demonstrate/evaluate interface mechanisms enabling C2 Information systems to use M&S systems in support of COAA and Coalition Force Mission Rehearsal
  - ⇨ Specification, demonstration and evaluation of a common, bi-directional interface enabling/supporting international experimentation in collaborative. coalition force C2 Mission Planning/Battle Management CPX's
- Demonstrate of a "state of the art", Web/XML based Collaboration Portal capability enabling/ supporting exchange of real-time CROP SA information with coalition Partners having on rudimentary C2I systems
- Refine Coalition Force Operational Procedures and experience with alternate and new ways of achieving interoperability